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OFF-GRID ENERGY IN 2030

AN EXERCISE IN FORESIGHTING

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Illustrations by James Durno

DISCLAIMER

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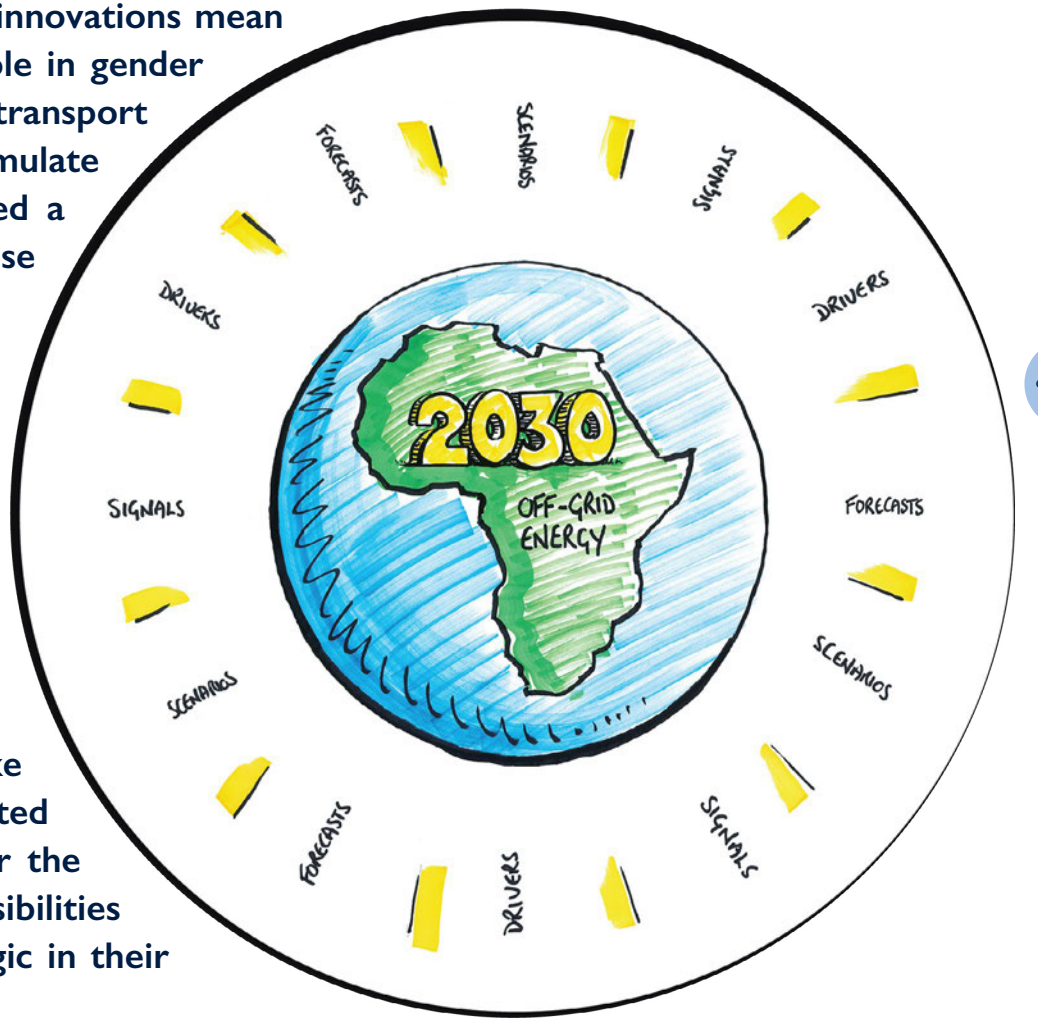
ABBREVIATIONS AND ACRONYMS

AEMDA	Association for Electric Mobility and Development in Africa
AI	Artificial intelligence
DRF	Digital Rights Foundation
E-mobility	Electric mobility
EV	Electric vehicle
GDP	Gross domestic product
GHG	Greenhouse gas
GW	Gigawatt
GWh	Gigawatt hour
ICE	Internal combustion engine
km	Kilometer
kVA	Kilovolt amperes
kW	Kilowatt
kWh	Kilowatt hour
LED	Light emitting diode
LiFi	Optical wireless communication using light
MW	Megawatt
PUE	Productive uses of energy
PV	Photovoltaic
SDGs	Sustainable development goals
SSA	Sub-Saharan Africa
UN	United Nations
USAID	United States Agency for International Development
USTDA	United States Trade and Development Agency

EXECUTIVE SUMMARY

What will the off-grid energy landscape in sub-Saharan Africa look like in 2030?

How can off-grid energy solutions increase the resiliency of communities to adverse climate shocks? What will increased connectivity and digital finance innovations mean for financial inclusion? How will the off-grid sector play a role in gender equity and vice versa? How will off-grid energy shape the transport systems of the future? To consider these questions and to stimulate discussion about future possibilities, Power Africa conducted a strategic foresight exercise with the findings of that exercise presented in this report.



The pages and illustrations ahead describe cultural, economic, technological, and environmental drivers and emergent signals that suggest disruptions and innovations that might become widespread. The report incorporates forecasts and scenarios that reflect on potential futures for the intersection of off-grid power and climate change, digital finance, gender equality, and electric mobility (e-mobility).

The visual scenarios for 2030 imagine and aim to provoke thought around a possible future world. The scenarios presented are not intended to predict events, but rather to empower the reader to imagine potential outcomes. By envisioning possibilities in this structured way, decision makers can be more strategic in their actions in the present to achieve goals set for the future.

STRATEGIC FORESIGHTING: METHODOLOGY AND MINDSET

Use HINDSIGHT to frame what is possible

To imagine the future is difficult because we are faced with today's constraints. However, change happens – and it can happen faster than we expect. Looking to the past can reveal where and how change has happened, preparing anyone to step out of today's constraints and explore the broadest range of what is possible tomorrow.

Identify INSIGHTS for opportunities and threats

This report points out opportunities that the off-grid industry can pursue today, threats to avoid, and what desirable futures can look like – a future-oriented twist to traditional benchmarking and innovation planning. Once we gain insight about the future, there is no going back to the old way of thinking.

For strategic foresight to drive meaningful change, it needs to be combined with a cycle that also includes hindsight, insight, and action.

Only when all four of these elements are linked together can forecasters realize their preferred futures. When reading this report, keep in mind this fundamental hindsight-foresight-insight-action cycle.

Anticipate the future with FORESIGHT

Foresight is the process of turning facts about the present into clear and actionable views of what the future might be like. Foresight is not prediction. It is thinking systematically about patterns of change and understanding any limiting assumptions about what is possible. This report describes emergent events to reveal the factors that are potentially crucial for the off-grid industry and community in sub-Saharan Africa.

This report references the language and methodologies of strategic foresight as practiced by the Institute for the Future.[1] Strategic foresight takes many forms, but the primary goal is to help organizations, governments, and communities to have meaningful, systematic conversations about future possibilities to prompt action in the present.

Build ACTION toward a preferred future

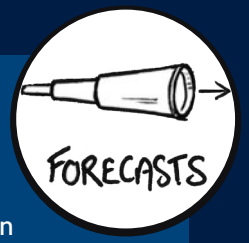
From the insights compiled in this report, decision makers can plan a way forward and express a clear vision that people will remember. Through action, leaders can create their preferred future for the industry and community.

[1] "IFTF: Who We Are," Institute for the Future, 2021, accessed June 25, 2021, www.iftf.org/what-we-do/who-we-are.

STRATEGIC FORESIGHTING: BASIC TERMS

This report highlights four scenarios that could influence the evolution of the off-grid industry between now and 2030. Each of these scenarios is supported by drivers, signals, and forecasts.

Drivers are factors that shape the world. They are ongoing "mega" or "macro" trends that point toward what the future might be like. Drivers can be cultural, economic, technological, or environmental, and they often have deep roots in historical patterns of change. Some drivers are recent developments; others, such as demographic shifts, may have been happening for several decades but will still influence the future. Drivers provide a good foundation for understanding the future but by themselves are incomplete.

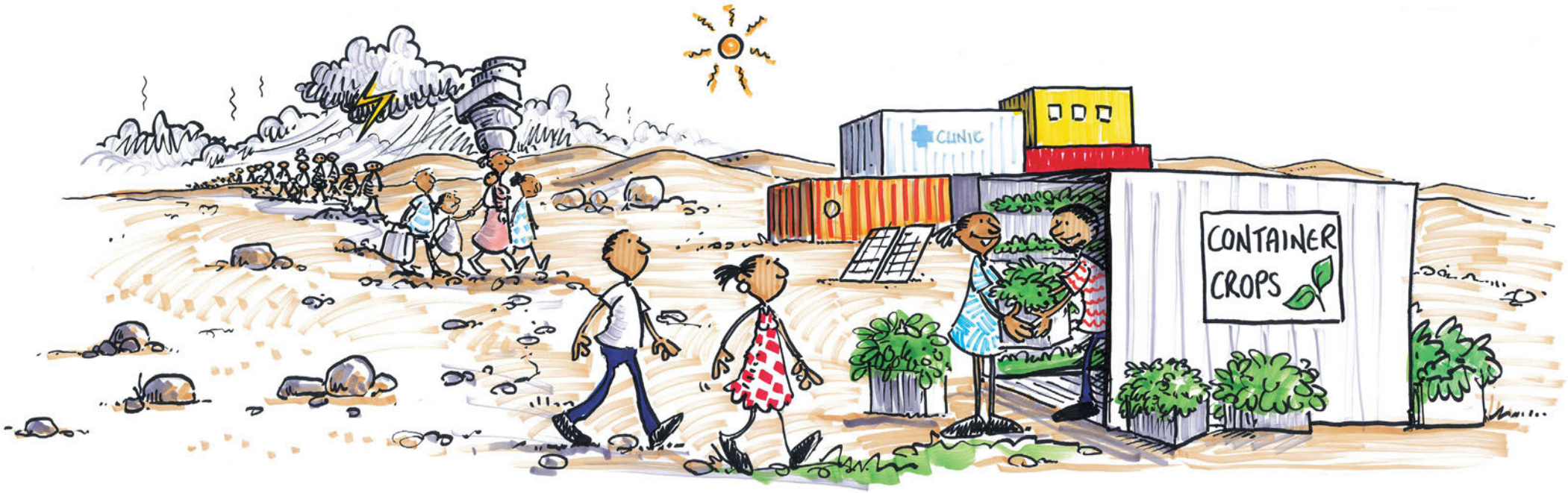


Forecasts are statements – an assertion, argument, story, artifact, scenario – about a possible future that provokes insights in the present about what could be in store later. A forecast is a plausible, internally consistent provocation about the future. In common usage, forecasts are often quantitative. In foresight practice, forecasts can be both quantitative and qualitative, if they are grounded in present-day facts. A forecast describes a range of plausible changes but does not predict a specific outcome. The forecasts in this report are statements about possible futures in the year 2030.

Signals are typically small and local innovations with the potential to disrupt an industry or to grow in scale and geographic distribution. A signal can be a new product, service, initiative, policy, data point, or technology. Unlike trends, signals turn our attention to possible innovations before they become obvious. Signals often focus our attention at the margins of society rather than the center and hint at disruptions and innovations that might become widespread.

Scenarios combine forecasts, drivers, and signals to describe a possible future world in vivid detail. The purpose of scenarios is to bring future possibilities to life, to make them tangible and visceral. Future possibilities can feel abstract or arbitrary, and scenarios help the reader to imagine what it could look and feel like to inhabit a particular future world. Scenarios let readers project themselves into these worlds to determine whether the future described is desirable or represents a timeline worth avoiding. Neuroscientific studies demonstrate that this level of specificity helps us to relate to our "future selves" living in these scenarios, and to apply this future-facing perspective to our present-day decision-making.

The following sections construct four scenarios according to this methodology for strategic foresight. For each scenario, the report discusses relevant drivers, signals, forecasts, and the resulting possibilities. Additionally, for each scenario, we include a fictional, illustrated story to assist the reader in imagining a possible future that incorporates the drivers, signals, forecasts, and possibilities discussed. The four scenarios highlight the intersection of off-grid power and climate change, digital finance, gender equality, and e-mobility.



OFF-GRID AND CLIMATE CHANGE

The increasing frequency and severity of extreme weather and natural disasters through 2030 and beyond will pose a significant risk to the growth and development of countries in sub-Saharan Africa. Severe weather driven by climate change will likely damage agricultural outputs and productivity growth. Hunger is likely to rise as food security decreases due to frequent crop failure. Migration flows will likely increase as climate refugees move due to climate shocks.

In response, climate adaptation strategies will need to include off-grid solutions. Containerized solar-powered solutions can make communities more resilient and allow for rapid deployment when infrastructure is damaged, or when displaced peoples must set up temporary settlements. Productive uses of energy (PUE), such as solar-powered pumping of ground water for irrigation, will be instrumental in shoring the resiliency of communities as traditional agricultural practices break down due to climate change.

Over the coming decades, severe weather is liable to become more frequent. The increasing likelihood of extreme weather events will affect the lives and livelihoods of many throughout sub-Saharan Africa. Reduced availability of arable land, frequent shocks to crops (*e.g.* drought and locusts), increased occurrence and severity of tropical cyclones, and record-breaking heat are just a few potential dangers.

Driver 1: Increased frequency and severity of extreme weather events

As global average temperatures and greenhouse gas (GHG) emissions keep rising, historically extreme and rare events will occur with increasing frequency and severity. Tropical cyclones will strike more often during potentially longer seasons. Droughts, wildfires, and floods will displace communities with increased regularity and harshness.[2] These consequences of climate change are emerging sooner than initially forecast.[3]

In December 2019, three tropical cyclones – Belna, Ambali, and Pawan – threatened parts of eastern Africa simultaneously. Over the course of 24 hours, Ambali's wind speed intensified by 115 miles (185 kilometres) per hour, breaking records for the Southern Hemisphere.[4]

In the same season, cyclones Idai and Kenneth set records as the "worst natural disaster to hit southern Africa in two decades." First making landfall in Mozambique, the storms left over 2.5 million people in need of urgent humanitarian assistance, including those in inland countries Malawi and Zimbabwe.[5]

As temperatures continue to rise, warming oceans and changing weather patterns around the world, weather events in Africa are likely to break modern precedents not only in frequency and severity, but in their unpredictability. More volatile weather makes pop-up infrastructure for emergency response efforts vital.

Driver 2: Increased regional migration

Persistent shocks due to climate change will force populations to abandon their homelands. Many of these shocks are already being felt in regions of sub-Saharan Africa. Droughts, flooding, and wildfires endanger people's property, livelihoods, and sources of food. For example, severe drought in Ethiopia has displaced more than 425,000 people. The same regions are also at a higher risk of flooding. In 2019, Djibouti experienced "two years' worth of rain fall in a single day" and pushed many who were already displaced into an even worse situation.[6]

Driver 3: Climate change, electricity, and healthcare resiliency

The COVID-19 pandemic has highlighted a long-standing issue for many healthcare systems in sub-Saharan Africa: The lack of reliable health-facility electrification. With reliable electricity access, healthcare facilities can perform procedures at all hours with proper lighting; refrigerate vaccines and medicines; sterilize equipment; conduct laboratory tests; and purify water. Without electricity, healthcare providers are less able to treat and prevent many illnesses and injuries.

Photo Credit: OffGridBox

[2] "Climate Change Indicators in the United States," U.S. EPA, last updated May 3, 2021, accessed June 25, 2021, www.epa.gov/climate-indicators#discover.
[3] "Climate Change Tipping Point Could Be Coming Sooner than We Think," *ScienceDaily*, January 23, 2019, accessed June 25, 2021, www.sciencedaily.com/releases/2019/01/190123131700.htm.
[4] Jonathan Belles, "Three Tropical Cyclones Lurked Near Africa this Week and One Set a New Rapid Intensification Record," The Weather Channel, December 8, 2019, accessed June 25, 2021, https://weather.com/storms/hurricane/news/2019-12-05-indian-ocean-dipole-el-nino-tropical-cyclone.
[5] "Cyclone Idai and Kenneth," UNICEF, accessed June 25, 2021, www.unicef.org/mozambique/en/cyclone-idai-and-kenneth.
[6] Laureen Fagan, "Africa's 'Climate Refugees' Are Already Here – and There," *Africa Times*, December 24, 2019, accessed June 25, 2021, https://africatimes.com/2019/12/24/africas-climate-refugees-are-already-here-and-there/.

The signals given by extreme weather patterns help us to identify some of the ways in which African countries are likely to be affected by climate change in the coming decade. These signals point to potential needs that the off-grid sector can anticipate, prepare for, and respond to.

Signal 1: Climate models predict outsized impacts for African continent

A 2018 study in the journal *Earth's Future* documents anticipated impacts of climate change in Africa, concluding that "the continent ... has to expect an increase in [hot nights] and longer and more frequent [heat waves] even if the global temperature increase will be kept below 2°C."[7] Even in best-case scenarios, changing weather conditions in the next several decades will require radical adaptation strategies to accommodate intensive periods of drought, flooding, and extreme heat at unpredictable intervals. The flexibility and modularity of off-grid infrastructure will be crucial in this adaptation.

Signal 2: Global indoor farming market projected to reach $ 12 billion by 2024

New technologies like vertical farms have emerged in the last decade as the costs of key components (*e.g.* LED grow lights) decreased exponentially. As communities seek out more climate-resilient infrastructure, the indoor farming market is projected to grow exponentially in the next five years.[8] One of the leading vertical-farming companies is US-based AeroFarms. On March 26, 2021, AeroFarms announced a partnership with Spring Valley Acquisition Corp. to become a publicly traded company. In the announcement, AeroFarms highlighted the $ 1.9 trillion market potential in the U.S. for leafy greens alone.[9]

Signal 3: Off-grid solutions to shocks

The COVID-19 pandemic is spurring innovation in the off-grid sector. Rapid-deploying containerized technologies are being developed and deployed to power temporary COVID-related infrastructure and existing healthcare facilities. OffGridBox, a USAID/Power Africa health-facility electrification awardee, repurposed their containerized off-grid power solution to provide reliable electricity access to power lights and medical equipment at six healthcare facilities in Rwanda.

OffGridBox's containerized systems provide both reliable electricity and clean water to healthcare facilities, with revenues from selling water cross-subsidizing the operation and maintenance of the systems. The boxes also create jobs and opportunity for women in the community, where box attendants help with water sales and phone charging.

Off-grid solutions allow for remote services in ways previously not possible. For example, schooling in Kenya moved to television and radio broadcasts during the country's COVID-19 lockdown. Off-grid power ensured access for children who would otherwise have been left behind in their schooling. By having electricity at home, learners could listen to lessons broadcast over radio and television.[10]

Signal 4: Increased funding for electrification of healthcare facilities

Donors are shifting funds to fill the electricity access gaps of healthcare facilities. Off-grid companies' renewed focus on health-facility electrification is spurring innovation and increased funding to fill energy access gaps and prepare healthcare systems for future shocks. Off-grid companies are retooling their existing offerings to fit the needs of healthcare facilities and are introducing novel solutions to old problems. For example, Power Africa awarded $ 2.6 million in grants for electrification of healthcare

[7] Torsten Weber *et. al.*, "Analyzing Regional Climate Change in Africa in a 1.5, 2, and 3°C Global Warming World," Earth's Future 6 (2018): 643–655.
[8] BIS Research, "Global Indoor Farming Technology Market Is Projected to Reach $ 12.02 Billion by 2024," Cision PR Newswire, July 17, 2019, accessed June 25, 2021, www.prnewswire.com/news-releases/global-indoor-farming-technology-market-is-projected-to-reach-12-02-billion-by-2024--300886437.html.
[9] "AeroFarms, the World Leader in Indoor Vertical Farming, to Become Publicly Traded Company through Combination with Spring Valley Acquisition Corp," *Business Wire*, March 26, 2021, accessed June 25, 2021, www.businesswire.com/news/home/20210326005074/en/AeroFarms-the-World-Leader-in-Indoor-Vertical-Farming-to-Become-Publicly-Traded-Company-through-Combination-with-Spring-Valley-Acquisition-Corp.
[10] Power Africa, "Information Needs Drive Demand for Off-grid Solar Products," Power Africa Blog, October 22, 2020, accessed June 25, 2021, https://powerafrica.medium.com/information-needs-drive-demand-for-off-grid-solar-products-984cd316bfc0.

facilities across sub-Saharan Africa, with a focus on rapid-response and commercial sustainability.[11] The awardees' solutions included containerized technologies for easy deployment and increased durability; self-contained water purification systems to ensure access to clean water and to provide a source of revenue; and nano-grids for electrifying small off-grid communities without power infrastructure.

Power Africa's health-facility electrification grant is helping to pilot the projects needed to mitigate climate shocks. Containerized farming and infrastructure can protect communities, especially those living off-grid, from climate shocks. Microenterprises for infrastructure can help cross-subsidize key operations within a community. Likewise, small-scale mini-grids can increase the self-sufficiency of off-grid communities when key infrastructure is incapacitated by extreme weather.

In the wake of COVID-19, investments in health-facility electrification not only make communities healthier, but will increase the resiliency of health systems in a future threatened by climate disasters.

POSSIBILITIES FOR CLIMATE CHANGE BY 2030

The period leading to 2030 will likely see widespread disruption caused by man-made global warming and extreme weather around the world. As we are already seeing many of the consequences of climate disruption (from extreme droughts to wildfires to storms), the next decade will likely see more record-setting extreme weather events in Africa and across the globe.

Cyclones in the Indian Ocean reaching the coast of East Africa are rare, but have started to appear with greater frequency, and threaten coastal infrastructure used for trade. Temperatures will continue to peak above seasonal averages, often with greater levels of humidity. These increases may cause shifts in rainfall patterns and animal behavior (such as migration), disrupting agriculture and economically important crops intended for export.

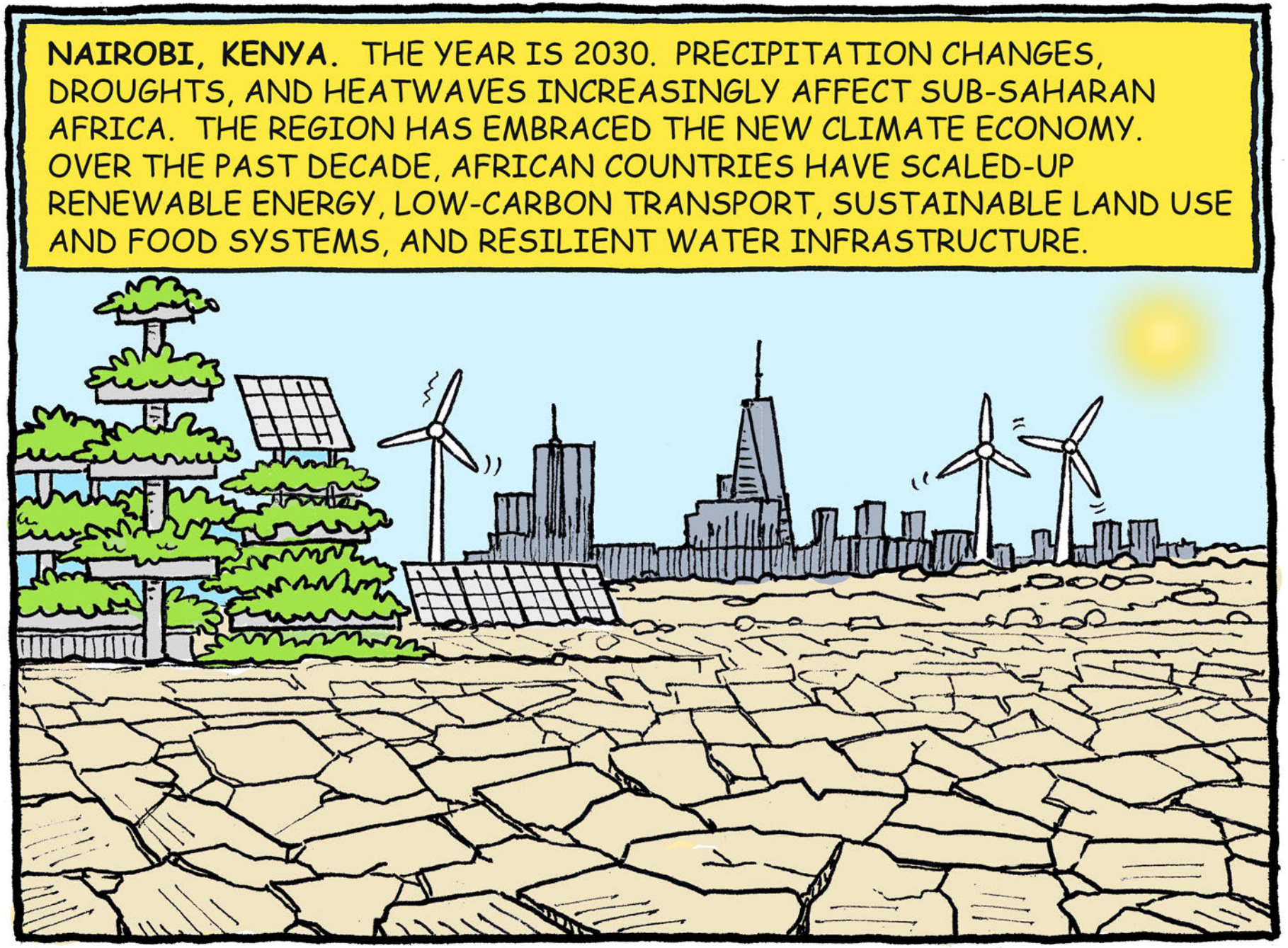
Climate change affects environmental determinants of health, including air quality, and access to water, food, and shelter. According to the U.S. Centers for Disease Control and Prevention "some existing health threats will intensify and new health threats will emerge."[12] Increased temperatures due to climate change will most likely accelerate the prevalence of diseases, for example vector-borne diseases that are more prevalent in warmer climates and communicable diseases that spread more rapidly in high-density populations.

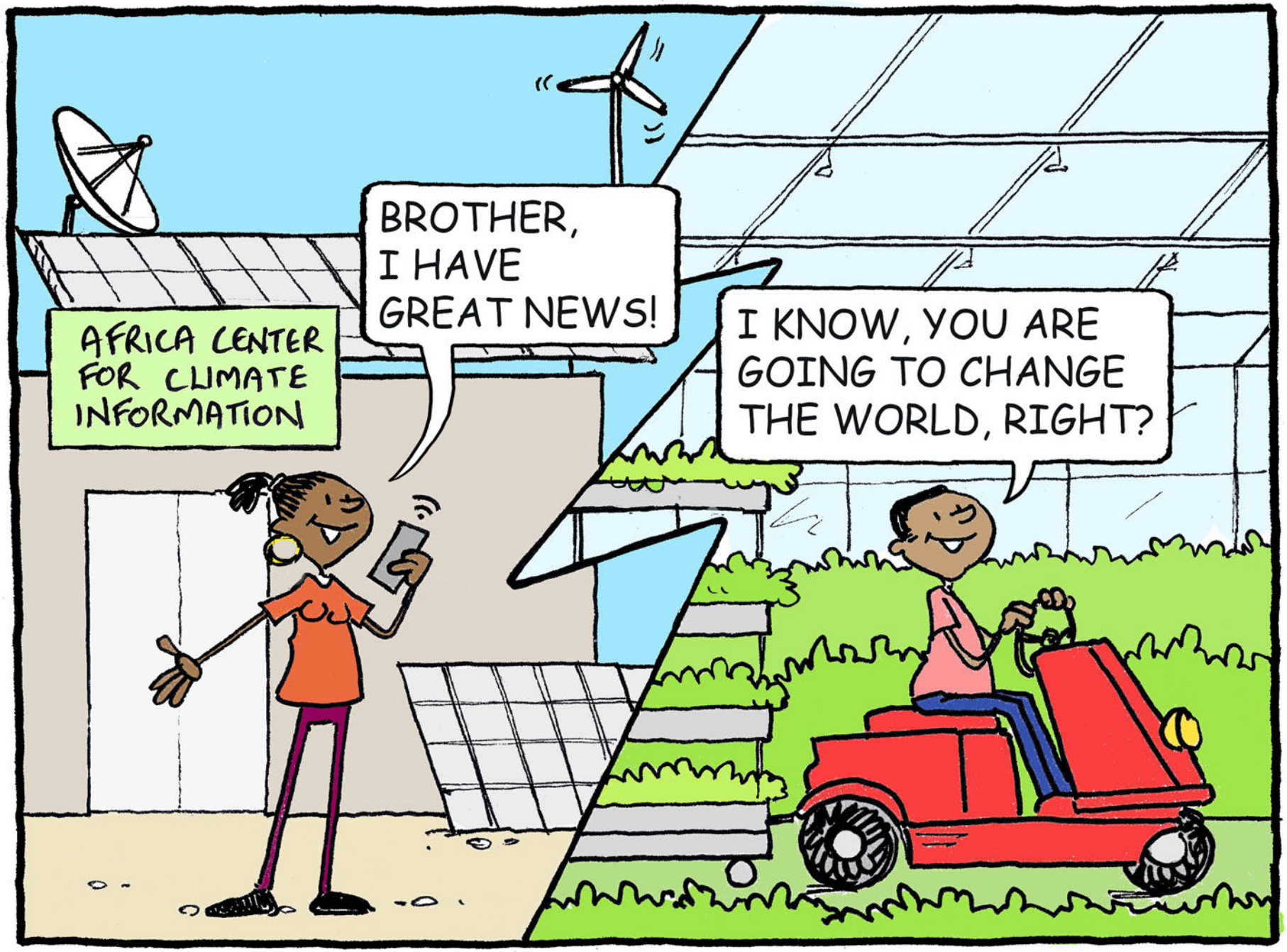
The likely increases in heat in the region, coupled with rising storm frequency and strength in the Western Indian Ocean, will trigger surges of climate migrants and climate refugees from regions without the necessary funds and infrastructure for rapid adaptation.

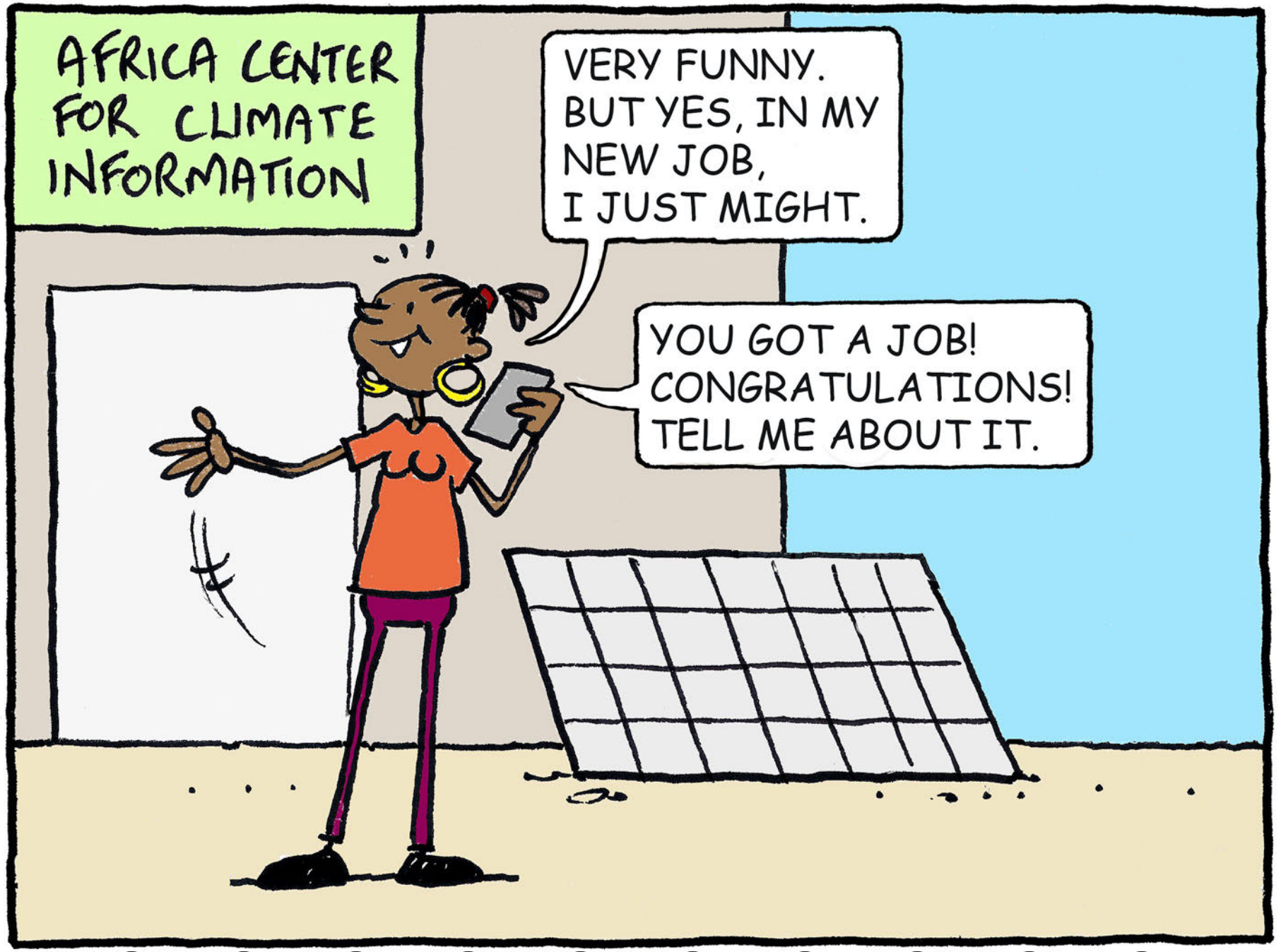
SCENARIO: CLIMATE CHANGE IN 2030

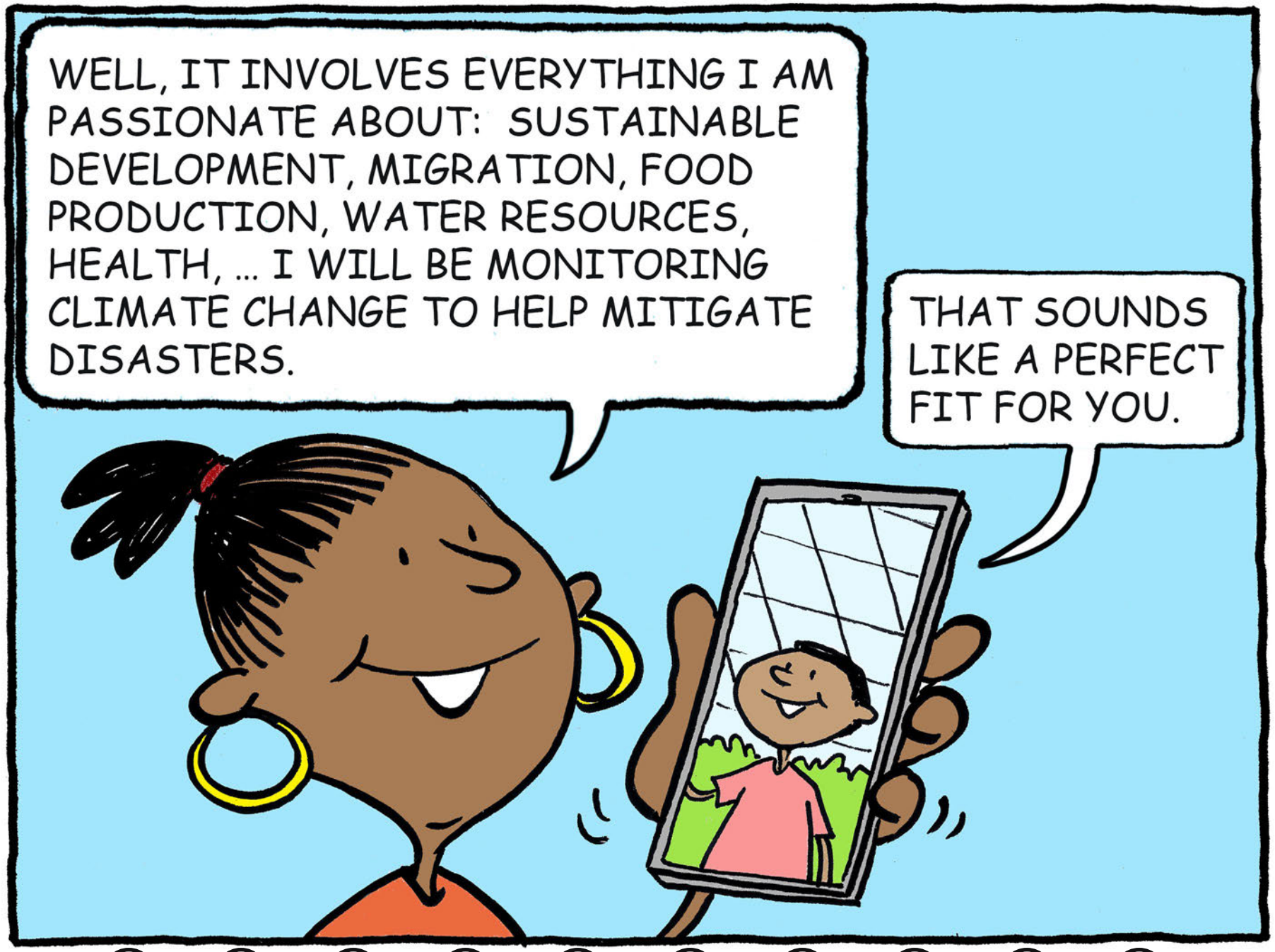
The following scenario for 2030 imagines a possible future world. It is not meant to operate as a prediction of events, but rather to provoke thought around future possibilities. The scenario aims to empower the reader to imagine the possible outcomes, over a ten-year time frame, of actions and policies we adopt today.

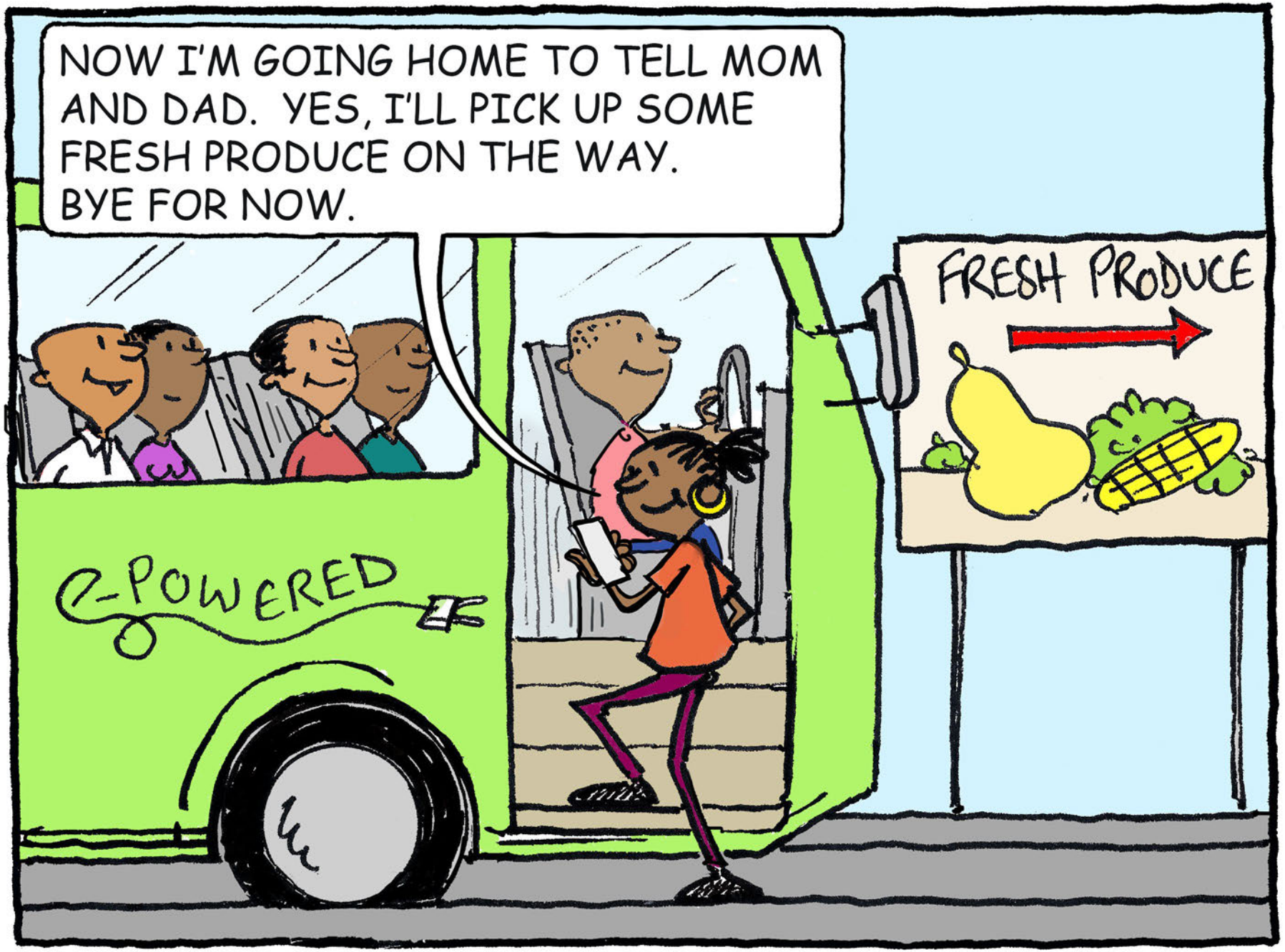
[11] Power Africa, "USAID/Power Africa Announces $ 2.6 Million in Healthcare Electrification Grants to Solar Energy Companies in Nine Countries in Sub-Saharan Africa," Power Africa Blog, September 22, 2020, accessed June 25, 2021, https://powerafrica.medium.com/usaid-power-africa-announces-2-6-c003fa75f004.
[12] CDC, "Climate Effects on Health," March 2, 2021, accessed June 29, 2021, www.cdc.gov/climateandhealth/effects/.


NAIROBI, KENYA. THE YEAR IS 2030. PRECIPITATION CHANGES, DROUGHTS, AND HEATWAVES INCREASINGLY AFFECT SUB-SAHARAN AFRICA. THE REGION HAS EMBRACED THE NEW CLIMATE ECONOMY. OVER THE PAST DECADE, AFRICAN COUNTRIES HAVE SCALED-UP RENEWABLE ENERGY, LOW-CARBON TRANSPORT, SUSTAINABLE LAND USE AND FOOD SYSTEMS, AND RESILIENT WATER INFRASTRUCTURE.

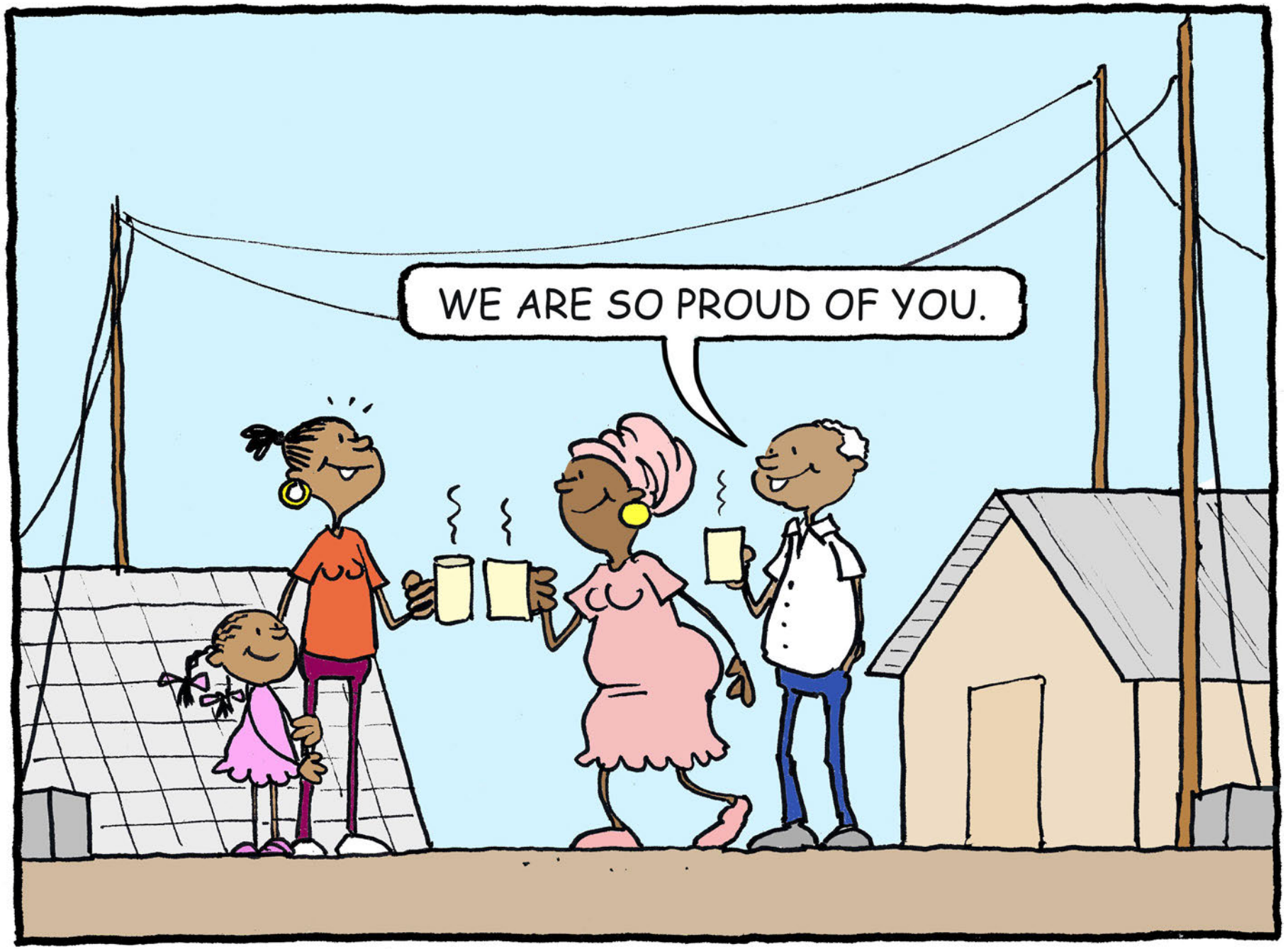

BROTHER, I HAVE GREAT NEWS!
AFRICA CENTER FOR CLIMATE INFORMATION
I KNOW, YOU ARE GOING TO CHANGE THE WORLD, RIGHT?


AFRICA CENTER FOR CLIMATE INFORMATION
VERY FUNNY. BUT YES, IN MY NEW JOB, I JUST MIGHT.
YOU GOT A JOB! CONGRATULATIONS! TELL ME ABOUT IT.

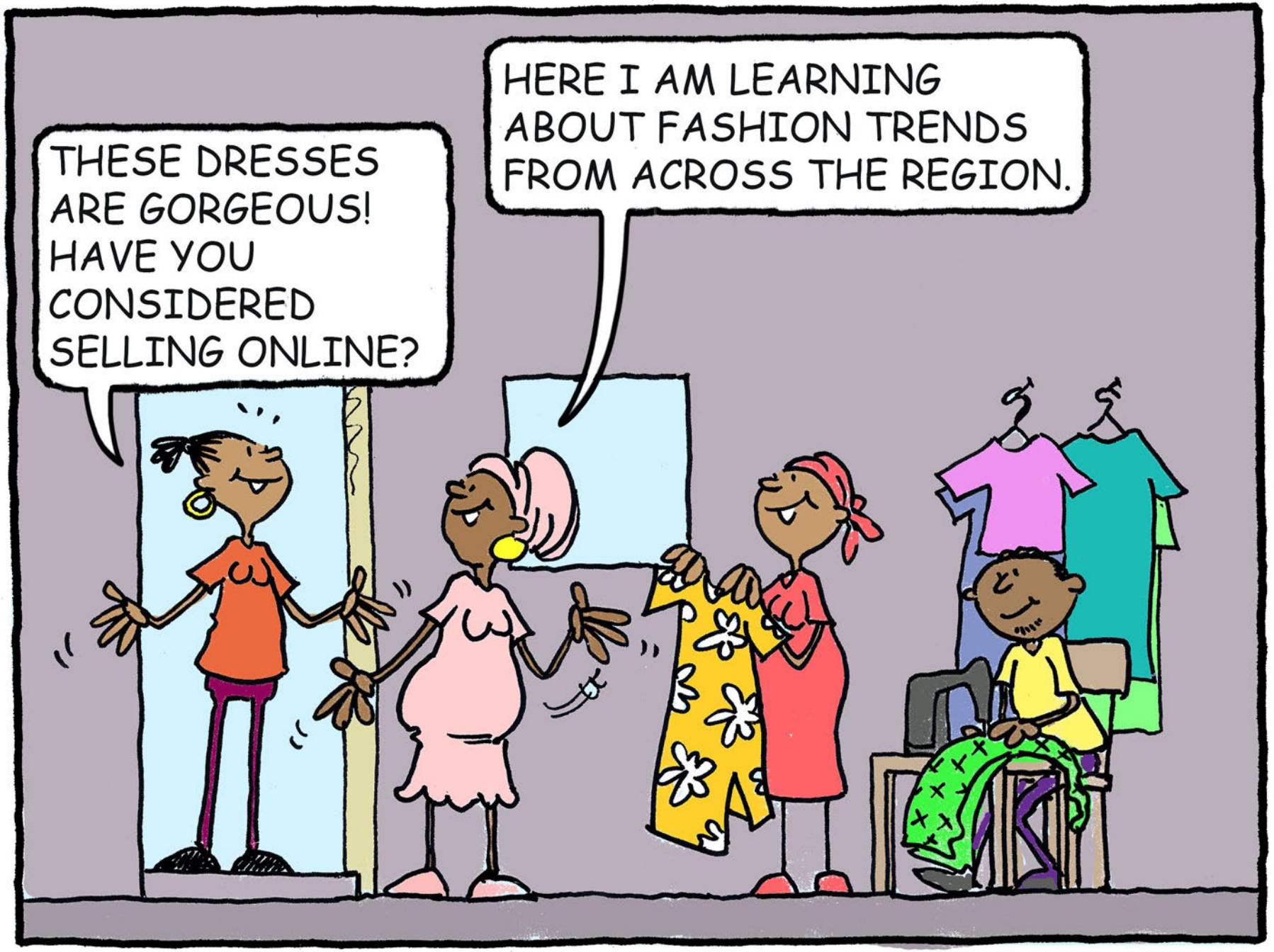

WELL, IT INVOLVES EVERYTHING I AM PASSIONATE ABOUT: SUSTAINABLE DEVELOPMENT, MIGRATION, FOOD PRODUCTION, WATER RESOURCES, HEALTH, ... I WILL BE MONITORING CLIMATE CHANGE TO HELP MITIGATE DISASTERS.
THAT SOUNDS LIKE A PERFECT FIT FOR YOU.

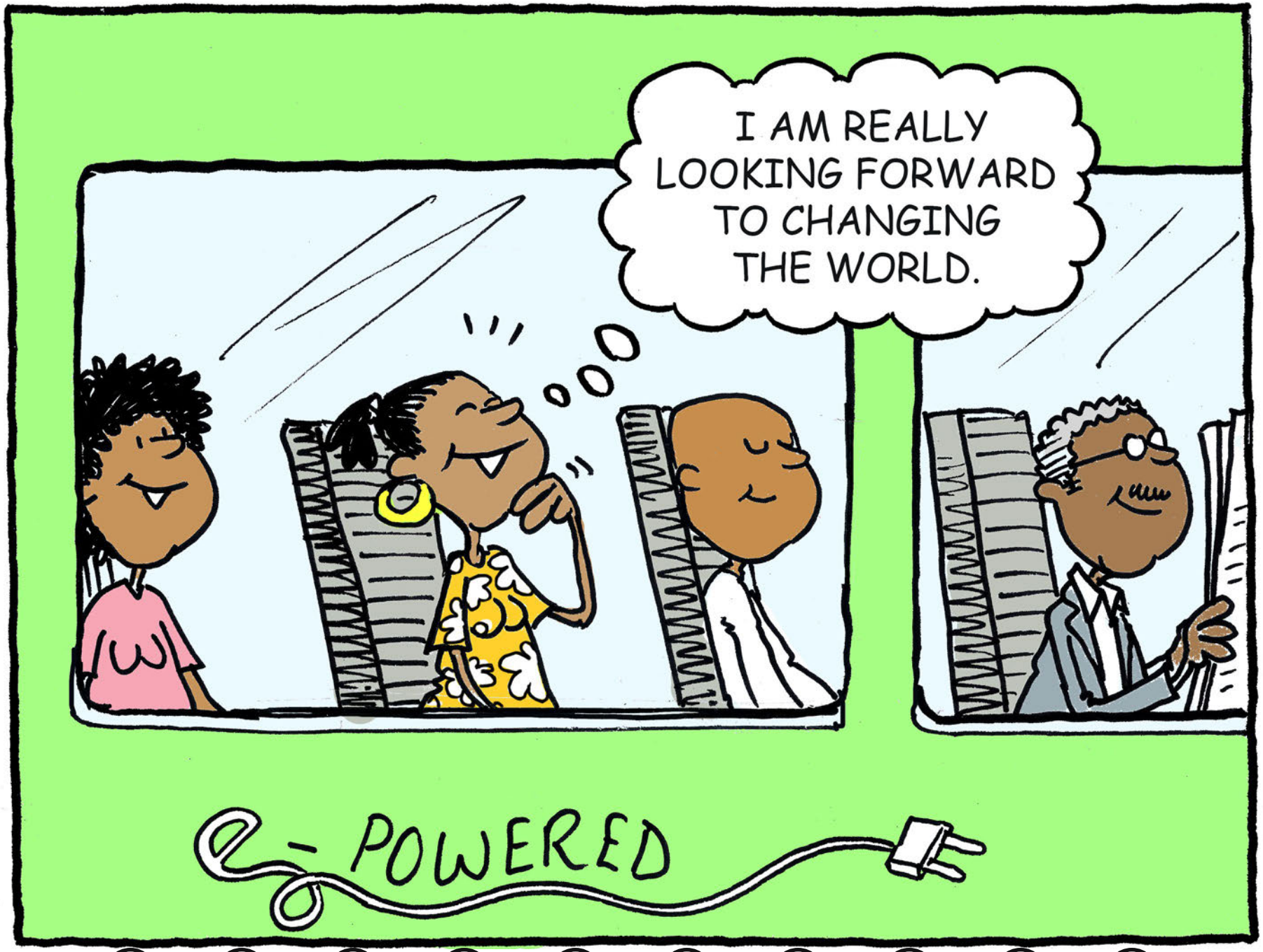

NOW I'M GOING HOME TO TELL MOM AND DAD. YES, I'LL PICK UP SOME FRESH PRODUCE ON THE WAY. BYE FOR NOW.
FRESH PRODUCE
E-POWERED

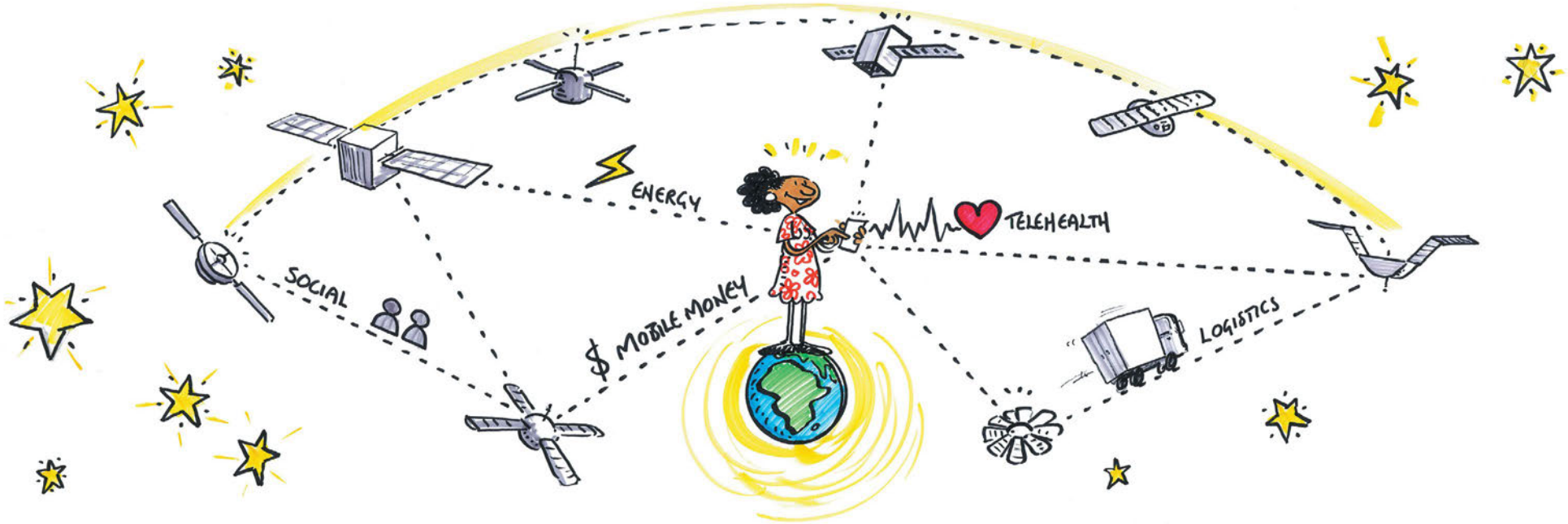

KESI, IT LOOKS LIKE YOU ARE BRINGING GOOD NEWS. WACHA TUNYWE CHAI NA WEWE!*
*LET'S HAVE TEA TOGETHER (IN SWAHILI)


WE ARE SO PROUD OF YOU.


NOW I WOULD LIKE TO SHOW YOU MY WORKPLACE.
REFUGEE SETTLEMENT


THESE DRESSES ARE GORGEOUS! HAVE YOU CONSIDERED SELLING ONLINE?
HERE I AM LEARNING ABOUT FASHION TRENDS FROM ACROSS THE REGION.


I AM REALLY LOOKING FORWARD TO CHANGING THE WORLD.
e- POWERED



OFF-GRID AND DIGITAL FINANCE

The growth of mobile phone use, especially in sub-Saharan Africa, is allowing widespread access to digital finance, such as banking, micro-lending, and mobile money. The expansion of digital finance is driving the growth of the off-grid market itself.

As digital finance services evolve and mature, they present many potent opportunities for economic and entrepreneurial development within and adjacent to the off-grid sector. However, this growth can come with trade-offs, including an increased reliance on algorithmic decision-making systems.

DRIVERS OF A DIGITAL FINANCE FUTURE

Driver 1: Growth in off-grid solar systems bundled with appliances

It is becoming increasingly common for appliances to be bundled with the purchase of an off-grid solar system.[13] Appliances such as solar lights, phone chargers, and refrigerators can mean increased household productivity. Appliances like televisions and radios can also improve household happiness and social inclusion.

Driver 2: Most unbanked individuals own mobile phones

The unbanked are adults who do not have accounts with formal financial institutions. Of the one billion unbanked people in the world, two-thirds own a mobile phone and represent an incredible need and opportunity for digital finance.[14] There are growing opportunities to deliver banking services to unbanked mobile phone owners through fintech innovations and digitized money. With these innovations, more of the world can participate in the modern global economy.

SIGNALS OF CHANGE FROM 2020

In 2020, we saw signals of change as digital networks expanded and digital currencies matured. These developments build momentum toward a potentially transformed financial landscape in 2030 and beyond.

Signal 1: Starlink will provide internet access to off-grid areas in Africa

SpaceX's Starlink program aims to achieve worldwide broadband coverage with a constellation of 30,000 satellites.[15] SpaceX plans to include Nigeria in beta testing Starlink, with other key African markets to follow.

SpaceX, along with competing initiatives at Boeing, OneWeb, Amazon, and Telesat, are working toward the goal of global internet coverage, which will enable individuals and small businesses to exchange money, metrics, and other information needed to run data-intensive operations no matter their location.[16]

Signal 2: Smart meters pave the way for energy-as-currency

Companies like Power Africa partner SparkMeter help to pave the way towards a network of distributed renewable electricity generation in an off-grid setting. Off-grid communities could eventually become interconnected with national grids and form mini-utilities. Smart meters like those offered by SparkMeter can benefit both the grid operator and the consumers.[17]

Photo Credit: SparkMeter

[13] GOGLA, *Global Off-grid Solar Market Report Semi-annual Sales and Impact Data* (GOGLA, 2020), www.gogla.org/sites/default/files/resource_docs/global_off-grid_solar_market_report_h2_2020.pdf.
[14] World Bank, *The Global Findex Database 2017* (Washington, D.C.: World Bank, 2020), https://globalfindex.worldbank.org.
[15] Nilay Patel, "Starlink Review," *The Verge*, May 14, 2021, accessed June 30, 2021, www.theverge.com/22435030/starlink-satellite-internet-spacex-review.
[16] Daniel Iyanda, "Elon Musk's Starlink Satellite Internet Targets Late 2021 Launch in Africa," *Space in Africa*, March 2, 2021, accessed June 24, 2021, https://africanews.space/starlink-satellite-internet-target-africa-coverage-late-2021-2022/.
[17] David Riposo and Dan Schnitzer, "Digital Energy Management and the Leaner, Cleaner Energy Systems of Africa's Future," *Power Africa Blog*, May 19, 2021, accessed June 24, 2021, https://powerafrica.medium.com/digital-energy-management-and-the-leaner-cleaner-energy-systems-of-africas-future-f544306a63f9.

Energy credits could lend themselves to a similar use, particularly because those living in sub-Saharan Africa spend such a high percentage of their income on energy. An energy-based currency means that individuals could possess as many energy rights as their cash reserves allow. If these credits are transferrable, they would make a convenient alternative to cash.[18]

Signal 3: AI-powered financial inclusion

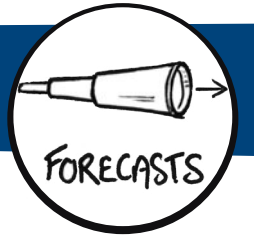
MyBucks is a South African fintech company that offers banking, lending, budgeting, and insurance services to unbanked and underbanked people in a dozen African countries. It uses artificial intelligence (AI) for fraud detection and to evaluate the creditworthiness of its users.[19]

Digital banks like MyBucks use fintech and AI to reduce operation costs by creating "clicks-not-bricks" automated banking services for people who have not had access to traditional banking services.

Signal 4: Digital finance as a lifeline during COVID-19

Digital finance and mobile banking make it easier for family members abroad to send money and resources to their relatives in sub-Saharan Africa. For example, remittances to sub-Saharan Africa declined somewhat in 2020 but have proven to be critical for some sub-Saharan Africa households to get by. As Michal Rutkowski, Global Director of the Social Protection and Jobs Global Practice at the World Bank, observed, while "COVID-19 still devastates families around the world, remittances continue to provide a critical lifeline for the poor and vulnerable."[20]

POSSIBILITIES FOR DIGITAL FINANCE BY 2030



Over 60 percent of people in sub-Saharan Africa do not have a bank account.[21] If you do not have a bank account, you are locked out of the larger financial system and have no path toward a better life. You cannot easily borrow capital to start a business, pay for goods and services, save money, buy insurance, obtain credit, or collect payments from customers. But in many sub-Saharan African countries, over 80 percent of the adult population owns a mobile phone[22] (a number that is increasing), and it is becoming easier to make sophisticated financial transactions using low-cost phones. The number of sub-Saharan Africans who have mobile money accounts doubled between 2014 and 2017.[23] In fact, there are ten countries in the world where more people have mobile money accounts rather than bank accounts, and all of them are in Africa.

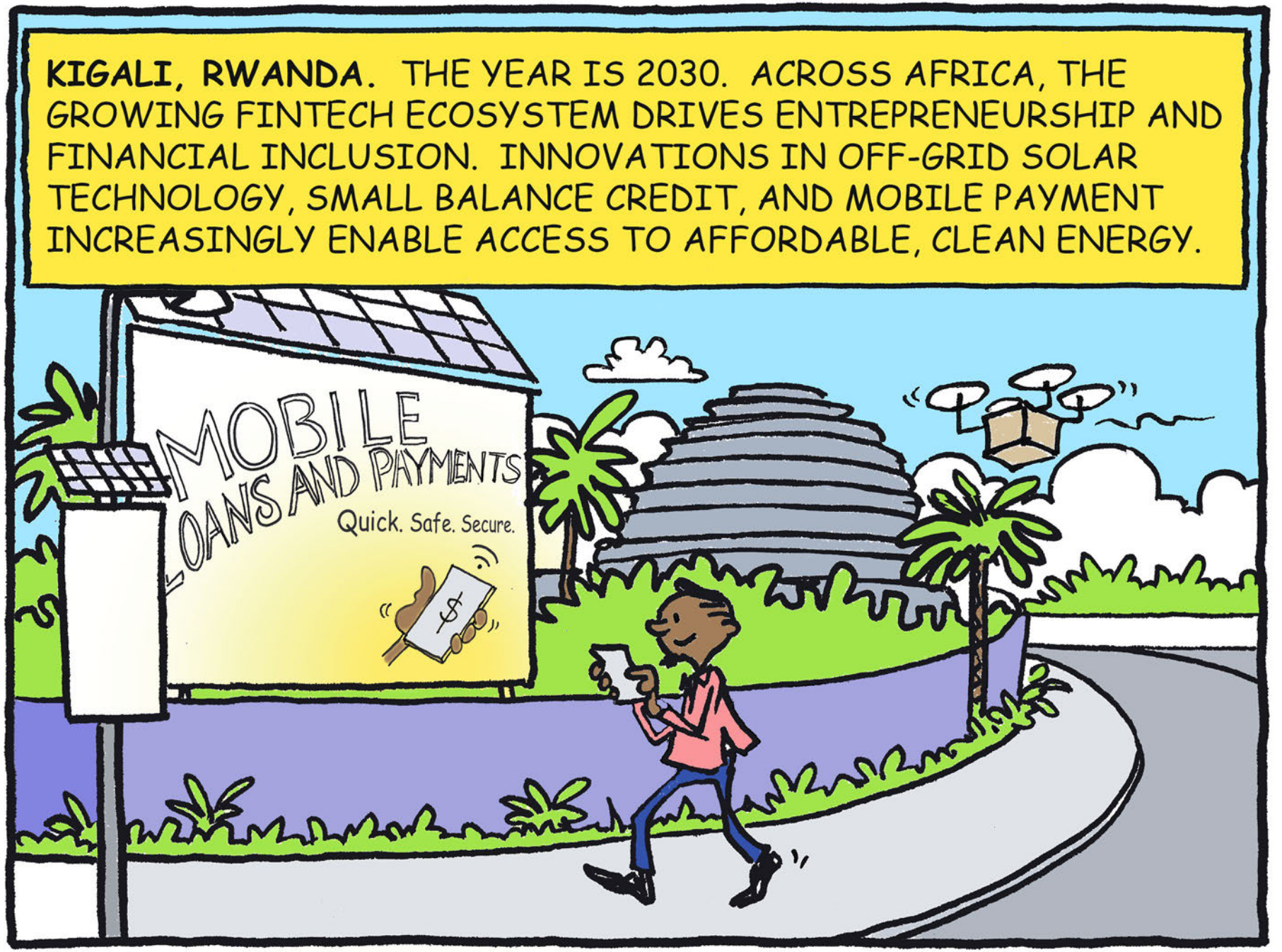
Blockchain technology can be useful in countries with unstable political climates and unreliable record-keeping. The relatively high cost of operating blockchains could be offset by their immutability, open access, resistance to censorship, and "borderlessness." Blockchain technology – which, unlike banks and mobile money systems, do not require a corruptible centralized platform – could enable "streaming money." Blockchains can allow people to buy solar-generated electricity by the milliwatt-minute instead of the traditional kilowatt hour.

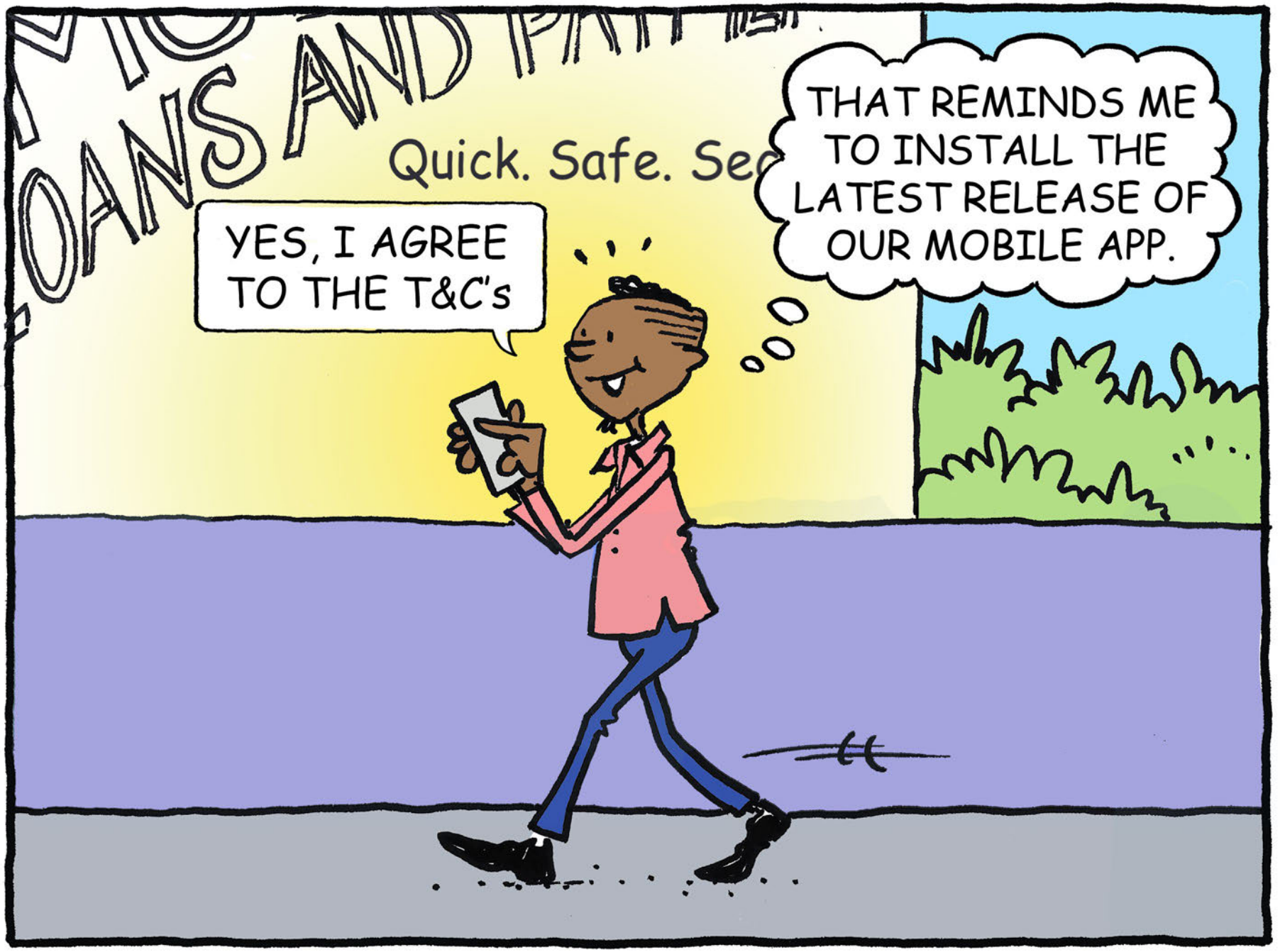
[18] "Airtime is Money," *The Economist*, January 19, 2013, accessed June 24, 2021, www.economist.com/finance-and-economics/2013/01/19/airtime-is-money.
[19] "About," OB1, accessed June 24, 2021, https://ob1.io/about.html.
[20] "Defying Predictions, Remittance Flows Remain Strong During COVID-19 Crisis," World Bank, May 12, 2021, accessed June 24, 2021, www.worldbank.org/en/news/press-release/2021/05/12/defying-predictions-remittance-flows-remain-strong-during-covid-19-crisis.
[21] "The 2017 Global Findex and the Fintech Revolution," World Bank, May 17, 2018, accessed June 24, 2021, www.worldbank.org/en/events/2018/04/23/global-findex-fintech-inclusion.
[22] Laura Silver and Courtney Johnson, "Majorities in Sub-Saharan Africa Own Mobile Phones, but Smartphone Adoption is Modest," Pew Research Center, October 9, 2018, accessed June 24, 2021, www.pewresearch.org/global/2018/10/09/majorities-in-sub-saharan-africa-own-mobile-phones-but-smartphone-adoption-is-modest/.
[23] "The 2017 Global Findex and the Fintech Revolution," World Bank, May 17, 2018, accessed June 24, 2021, www.worldbank.org/en/events/2018/04/23/global-findex-fintech-inclusion.

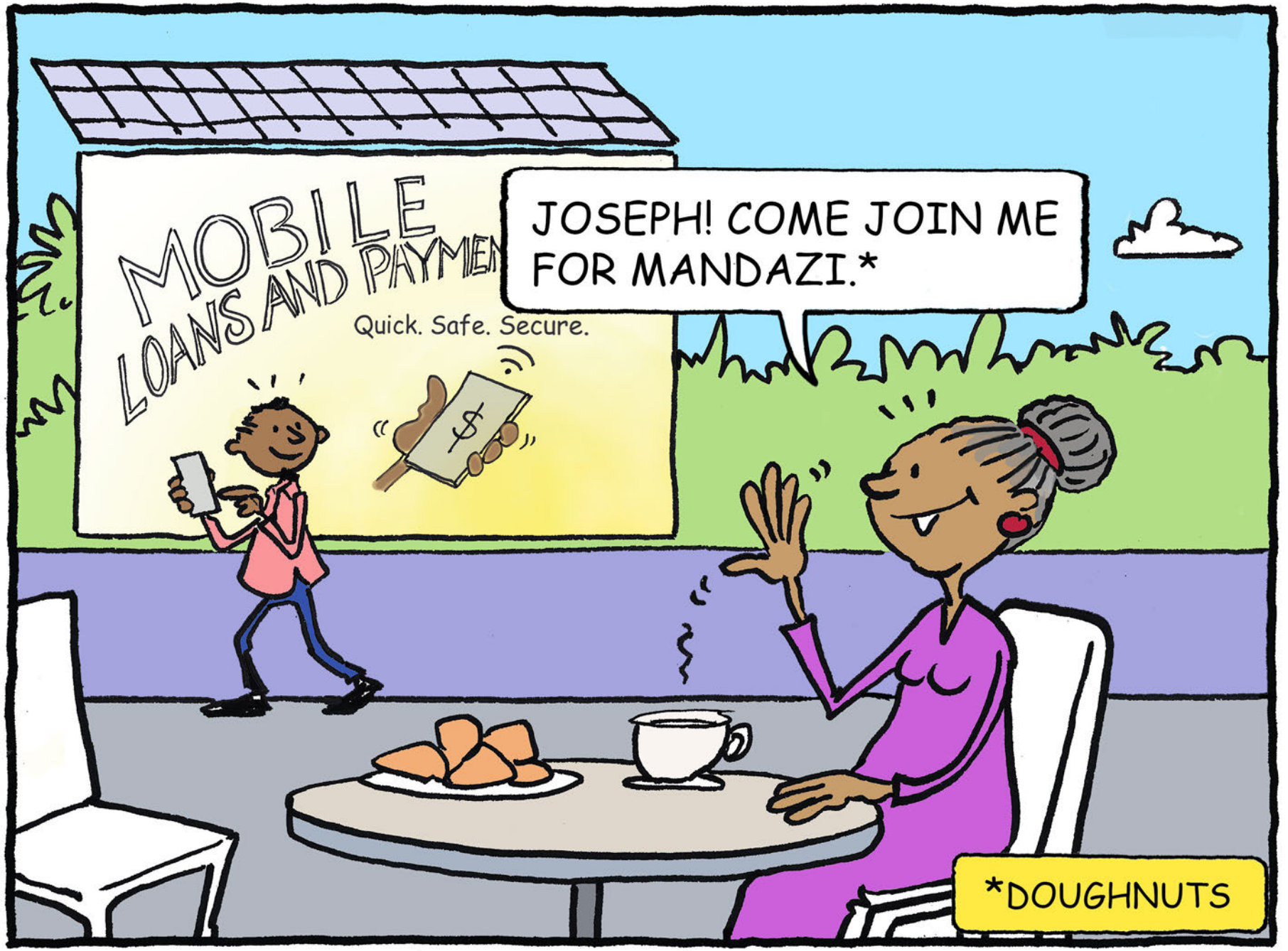
The traditional financing model in Africa for solar home systems is pay-as-you-go, where customers pay a monthly fee that is about as much as they would spend on lantern kerosene. But with streaming money, mobile money accounts, and Internet connectivity, customers can pay for exactly the amount of energy they use and sell excess capacity at a premium, either through a connection to a local grid or a battery charging service. They can also use the electricity to mine cryptocurrencies, run servers, or sell idle computer processing power through services like LoadTeam or Golem Network.

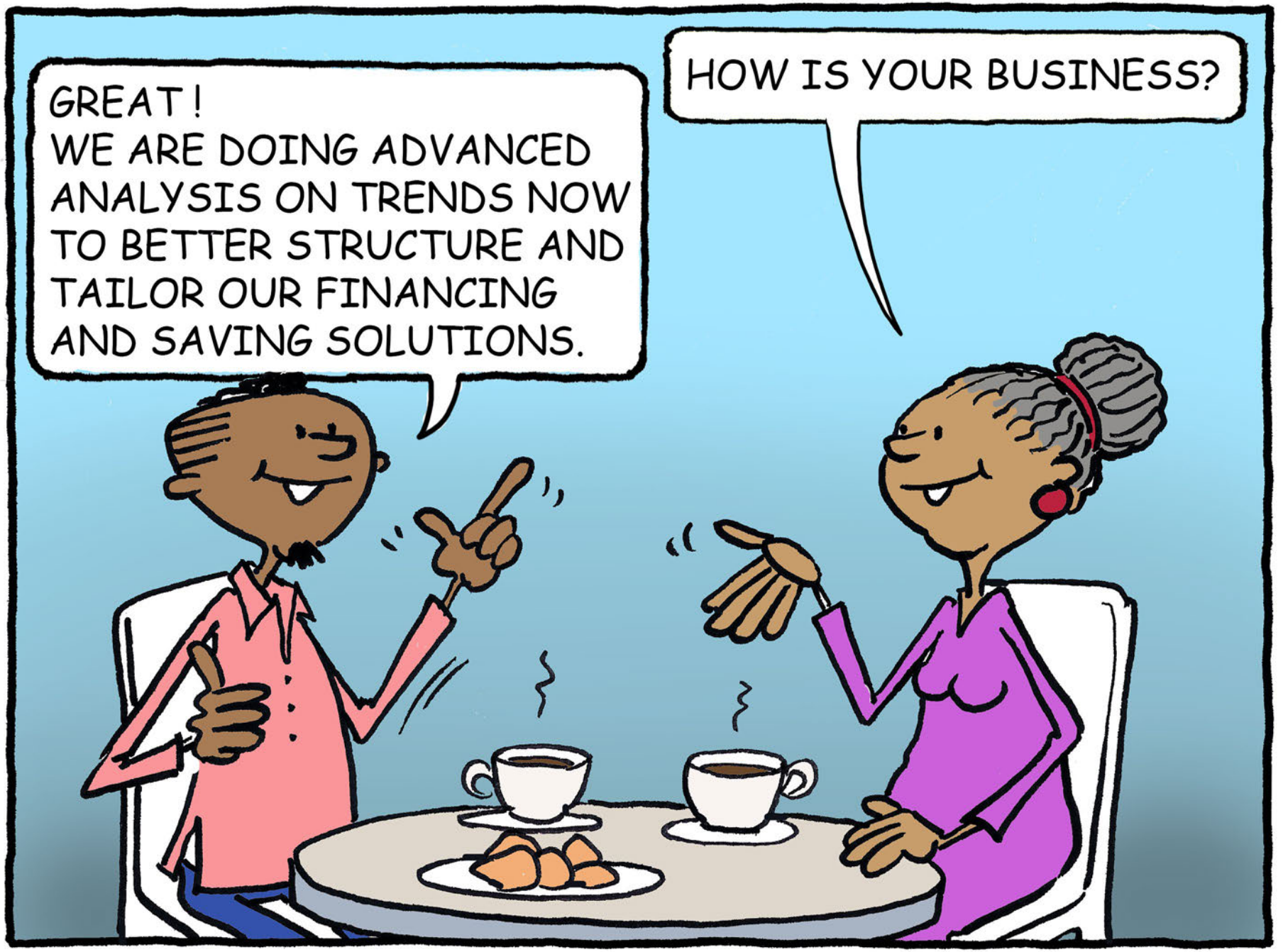
SCENARIO: DIGITAL FINANCE IN 2030

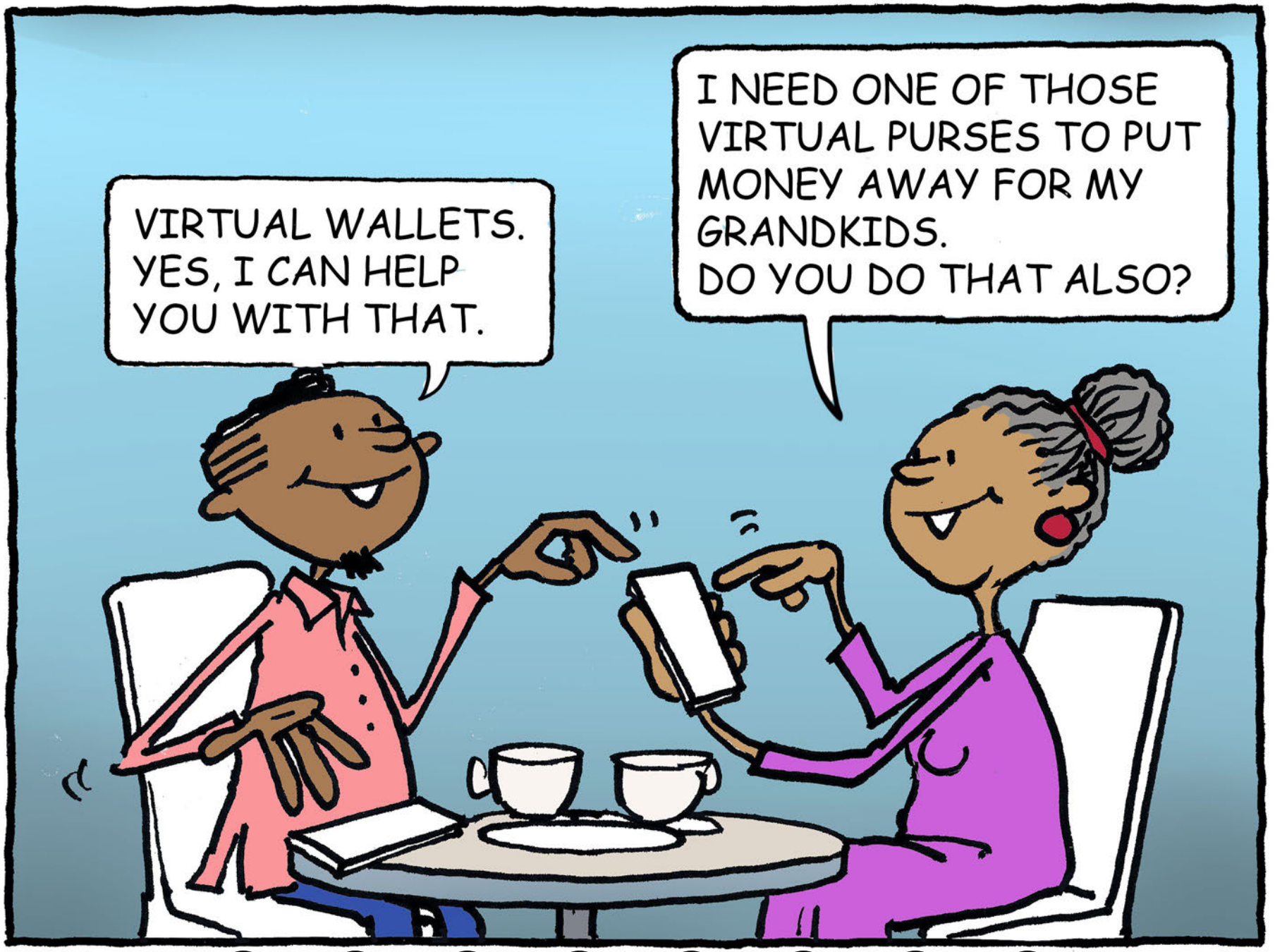
The following scenario for 2030 imagines a possible future world. It is not meant to operate as a prediction of events, but rather to provoke thought around future possibilities. The scenario aims to empower the reader to imagine the possible outcomes, over a ten-year time frame, of actions and policies we adopt today.

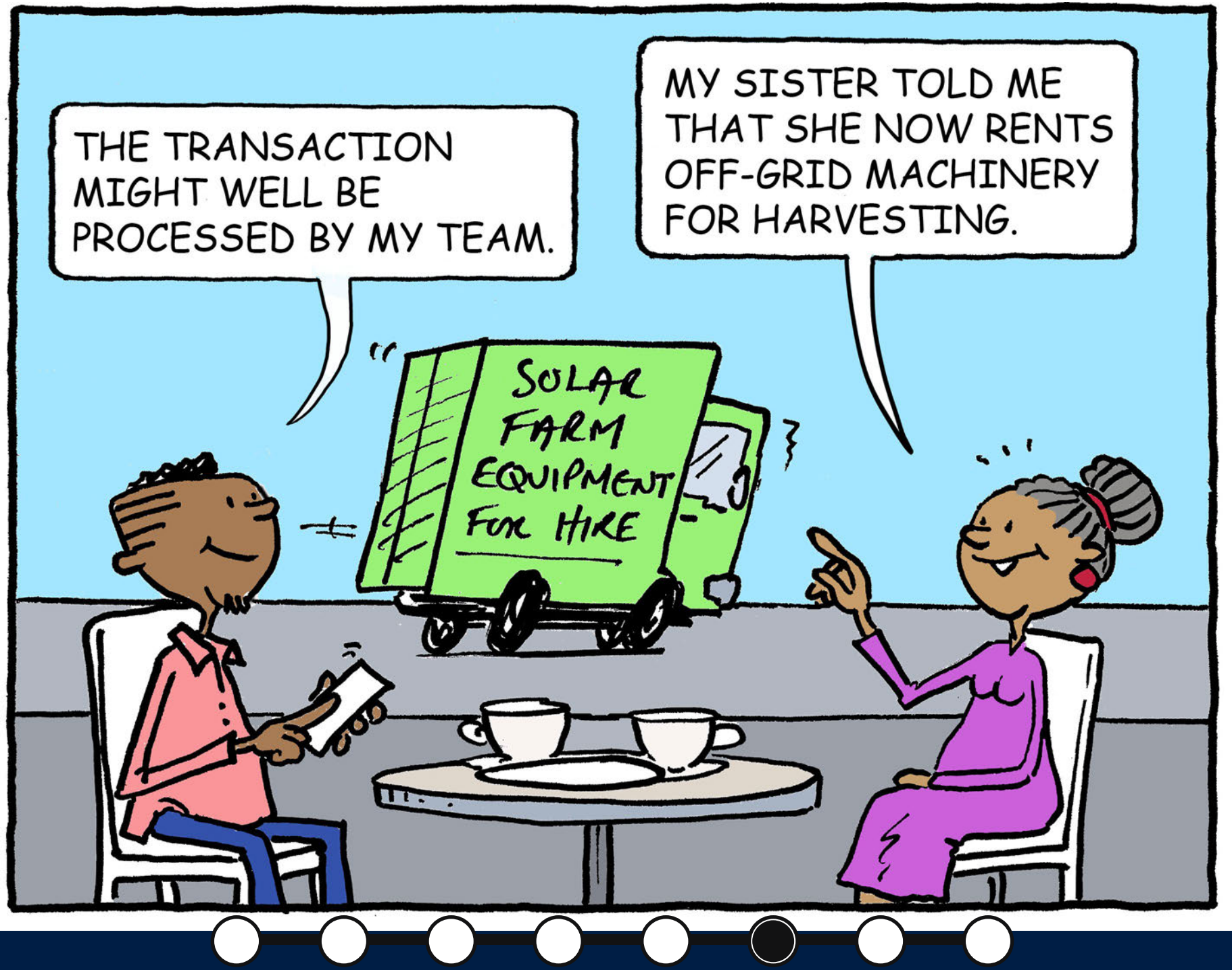

KIGALI, RWANDA. THE YEAR IS 2030. ACROSS AFRICA, THE GROWING FINTECH ECOSYSTEM DRIVES ENTREPRENEURSHIP AND FINANCIAL INCLUSION. INNOVATIONS IN OFF-GRID SOLAR TECHNOLOGY, SMALL BALANCE CREDIT, AND MOBILE PAYMENT INCREASINGLY ENABLE ACCESS TO AFFORDABLE, CLEAN ENERGY.
MOBILE
LOANS AND PAYMENTS
Quick. Safe. Secure.

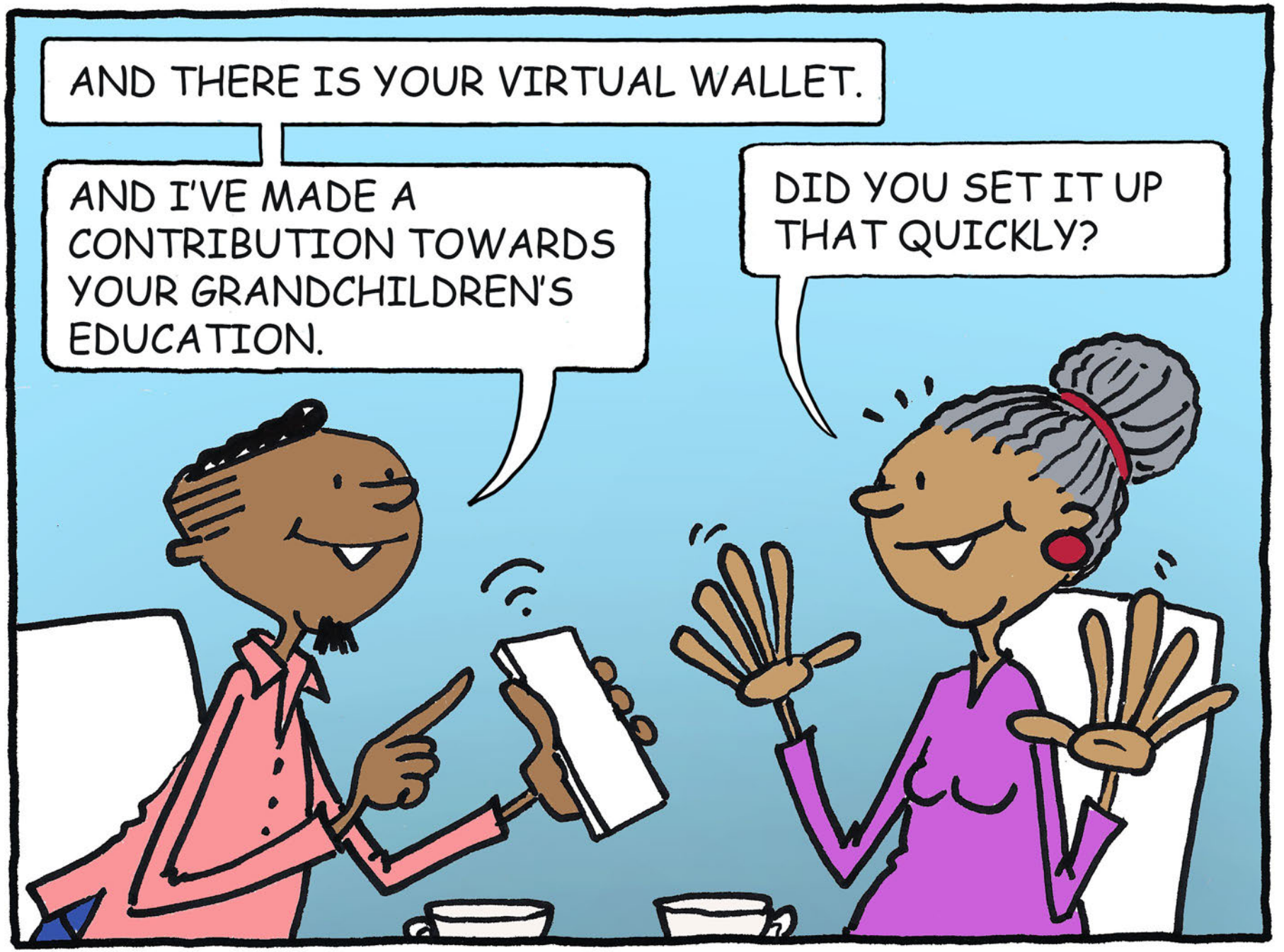

LOANS AND
Quick. Safe. Sec
YES, I AGREE TO THE T&C's
THAT REMINDS ME TO INSTALL THE LATEST RELEASE OF OUR MOBILE APP.

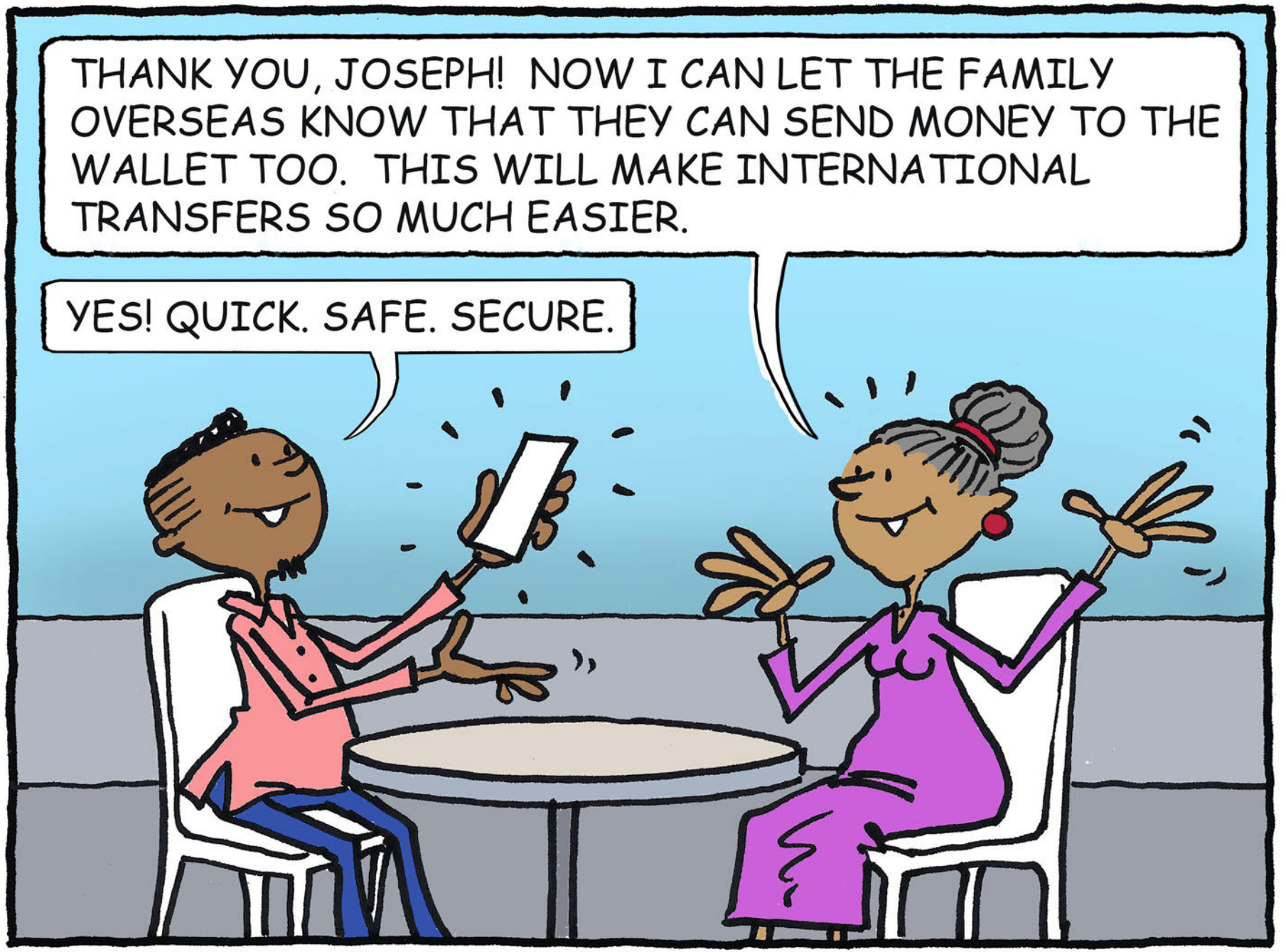

MOBILE
LOANS AND PAYMEN
Quick. Safe. Secure.
JOSEPH! COME JOIN ME FOR MANDAZI.*
*DOUGHNUTS


HOW IS YOUR BUSINESS?
GREAT!
WE ARE DOING ADVANCED ANALYSIS ON TRENDS NOW TO BETTER STRUCTURE AND TAILOR OUR FINANCING AND SAVING SOLUTIONS.


I NEED ONE OF THOSE VIRTUAL PURSES TO PUT MONEY AWAY FOR MY GRANDKIDS. DO YOU DO THAT ALSO?
VIRTUAL WALLETS. YES, I CAN HELP YOU WITH THAT.


THE TRANSACTION MIGHT WELL BE PROCESSED BY MY TEAM.
MY SISTER TOLD ME THAT SHE NOW RENTS OFF-GRID MACHINERY FOR HARVESTING.
SOLAR FARM EQUIPMENT FOR HIRE


AND THERE IS YOUR VIRTUAL WALLET.
AND I'VE MADE A CONTRIBUTION TOWARDS YOUR GRANDCHILDREN'S EDUCATION.
DID YOU SET IT UP THAT QUICKLY?


THANK YOU, JOSEPH! NOW I CAN LET THE FAMILY OVERSEAS KNOW THAT THEY CAN SEND MONEY TO THE WALLET TOO. THIS WILL MAKE INTERNATIONAL TRANSFERS SO MUCH EASIER.
YES! QUICK. SAFE. SECURE.

OFF-GRID AND GENDER EQUALITY

Around the world, attitudes toward gender roles are changing and driving a gender-equitable future. These changes are reflected in policy outcomes and promising demographic trends. These developments portend an evolving future for gender roles across Africa and the world.

Driver 1: Gender equality fueled by policy and investment

United Nations (UN) Sustainability Development Goal (SDG) five – achieve gender equality and empower all women and girls – highlights the need for gender-lens policy and investment interventions.[24] Without these interventions the gender financing gap will persist. Currently, the gender financing gap is estimated to be $ 42 billion for African women compared to their male counterparts.[25] Because one in four women in sub-Saharan Africa seek to start or manage a business, gender disparities in access to finance prevents economic growth in the region.[26]

Driver 2: Booming youth populations

Globally, 19 of the top 20 youngest nations are in Africa, where youthful populations are booming.[27] The 2018 Goalkeepers Report published by the Bill & Melinda Gates Foundation notes the importance of young populations more broadly: "Today's booming youth populations can be good news for the economy; if young people are healthy, educated and productive, there are more people to do the kind of innovative work that stimulates rapid growth." But the report highlights the need for investment in human capital to make this a reality.[28]

Driver 3: Rising urbanization

In 2018, the UN estimated that 55 percent of the world's population lived in cities, and projected a rise in urbanization to 68 percent of the population by 2050.[29] Many African cities are projected to grow dramatically in size over the next several decades, with Lagos, Luanda and Kinshasa frequently cited in surveys of the top ten fastest-growing cities.[30]

[24] "Goal 5: Achieve Gender Equality and Empower All Women and Girls," United Nations Department of Economic and Social Affairs: Sustainable Development, accessed June 24, 2021, https://sdgs.un.org/goals/goal5.
[25] "Why AFAWA?" African Development Bank, accessed June 24, 2021, www.afdb.org/en/topics-and-sectors/initiatives-partnerships/afawa-affirmative-finance-action-for-women-in-africa/why-afawa.
[26] Mike Herrington and Donna Kelley, GEM 2012 Sub-Saharan Africa Regional Report (GEM Consortium, 2013), www.gemconsortium.org/report/gem-2012-sub-saharan-africa-regional-report.
[27] Joe Myers, "19 of the World's 20 Youngest Countries Are in Africa," World Economic Forum, August 30, 2019, accessed June 24, 2021, www.weforum.org/agenda/2019/08/youngest-populations-africa/.
[28] Bill & Melinda Gates Foundation, *The 2018 Goalkeepers Report* (Bill & Melinda Gates Foundation, 2018), www.gatesfoundation.org/goalkeepers/report/2018-report/.
[29] "68% of the World Population Projected to Live in Urban Areas by 2050, says UN," United Nations Department of Economic and Social Affairs, 16 May, 2018, accessed June 25, 2021, www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html.
[30] "The World's 20 Fastest Growing Cities," The Telegraph, September 3, 2017, accessed June 25, 2021, www.telegraph.co.uk/travel/lists/fastest-growing-cities-in-the-world/.

Photo Credit: Power Africa

Present-day signals around gender equality help us to track the progress of changing assumptions regarding gender roles, and point towards the possible trajectory of a more gender-equitable world in 2030.

Signal 1: Last-mile entrepreneurs: Women are driving the off-grid solar industry

Research studies from ENERGIA highlight the relationship between women's energy entrepreneurship and "last-mile" energy access, pointing out multiple development gains.[31] Investing in women to act as ambassadors for electrification can both ensure greater success and bring additional benefits such as agriculture gains and expansion in educational opportunity.

Signal 2: Bidhaa Sasa case study on gender-smart investing

Bidhaa Sasa uses what it calls a "Group Leader" model to sell off-grid products such as solar pumps and clean cookstoves. Group Leaders "work their networks to create groups of clients who join together in group financing."[32] Bidhaa Sasa's group-payments model shows that female consumers have the financial ability and interest to buy clean technology like clean cookstoves when engaged through a group-leader model that brings in other women and engages their male partners to support purchasing.

Signal 3: Electric cooperatives offer customer satisfaction advantages

Per the National Rural Electric Cooperative Association in the U.S., "electric cooperatives, on average, score three points higher than all other electric companies, according to the 2017 American Consumer Satisfaction Index."[33]

Because cooperatives are shaped and influenced by the communities they serve and often composed of some of those same community members, they enjoy a greater level of trust and loyalty compared to traditional utilities, while returning a share of revenue to consumer-members and supporting job creation.

Signal 4: How one woman in Pakistan is fighting to make the internet a safer place for women

Nighat Dad founded the Digital Rights Foundation (DRF),[34] which imagines a world with a "feminist Internet": A place accessible to everyone who supports agency and expression, shows compassion and empathy, and enables economic opportunity for Pakistani women.[35] Applying human rights to digital spaces raises standards of accountability online, while also calling upon governments to protect women's right to civic participation and economic opportunity.

Signal 5: The digital finance divide widened during COVID-19

When the global economy came to a near standstill in 2020, the impacts of COVID-19 differed for men and women. For example, more women than men lost jobs since the start of the pandemic.[36] Many women-owned businesses and jobs held by women are in sectors most likely to be affected by lockdowns. The digital finance divide between men and women has only widened due to the pandemic.[37]

[31] Soma Dutta, *Supporting Last-mile Women Energy Entrepreneurs: What Works and What Does Not* (ENERGIA, December 2018), www.energia.org/cm2/wp-content/uploads/2019/01/Supporting-Last-Mile-Women-Entrepreneurs.pdf.
[32] "Gender Smart Investing: Off-grid Energy Case Study," Bidhaa Sasa, www.icrw.org/wp-content/uploads/2018/12/ICRW_Bidhaa-Sasa_CaseStudy.pdf.
[33] "Electric Co-op Facts & Figures," NRECA, April 16, 2021, accessed June 25, 2021, www.electric.coop/wp-content/uploads/2021/06/Co-op-Facts-and-Figures.pdf.
[34] "Research," Digital Rights Foundation, accessed June 25, 2021, https://digitalrightsfoundation.pk/work/research/.
[35] Patrick D'Arcy, "How One Woman in Pakistan Is Fighting to Make the Internet a Safer Place for Women," TED, March 8, 2018, accessed June 25, 2021, https://ideas.ted.com/how-one-woman-in-pakistan-is-fighting-to-make-the-internet-a-safer-place-for-women/.
[36] "COVID-19 Gender Gap Shows Need to Close Financial Inclusion Gender Gap," UNCTAD, April 26, 2021, accessed June 25, 2021, https://unctad.org/news/covid-19-shows-need-close-financial-inclusion-gender-gap.
[37] Pamella Eunice Ahairwe and San Bilal, *A Gender-sensitive Sustainable COVID-19 Recovery: The Role of Development Finance Institutions*. Discussion paper no. 284 (Maastricht, The Netherlands: ECDPM, October, 2020), https://ecdpm.org/wp-content/uploads/Gender-Sensitive-Sustainable-COVID-19-Recovery-Role-Development-Finance-Institutions-ECDPM-Discussion-Paper-284-2020.pdf.

POSSIBILITIES FOR GENDER EQUALITY BY 2030

Powered by changing attitudes, policies, and global campaigns such as the UN Sustainable Development Goals, the off-grid sector is poised to help pioneer more gender-equitable societies and economies across Africa by 2030. These efforts can take advantage of new opportunities to enlist non-traditional workers in creating new businesses, and drive women's empowerment.

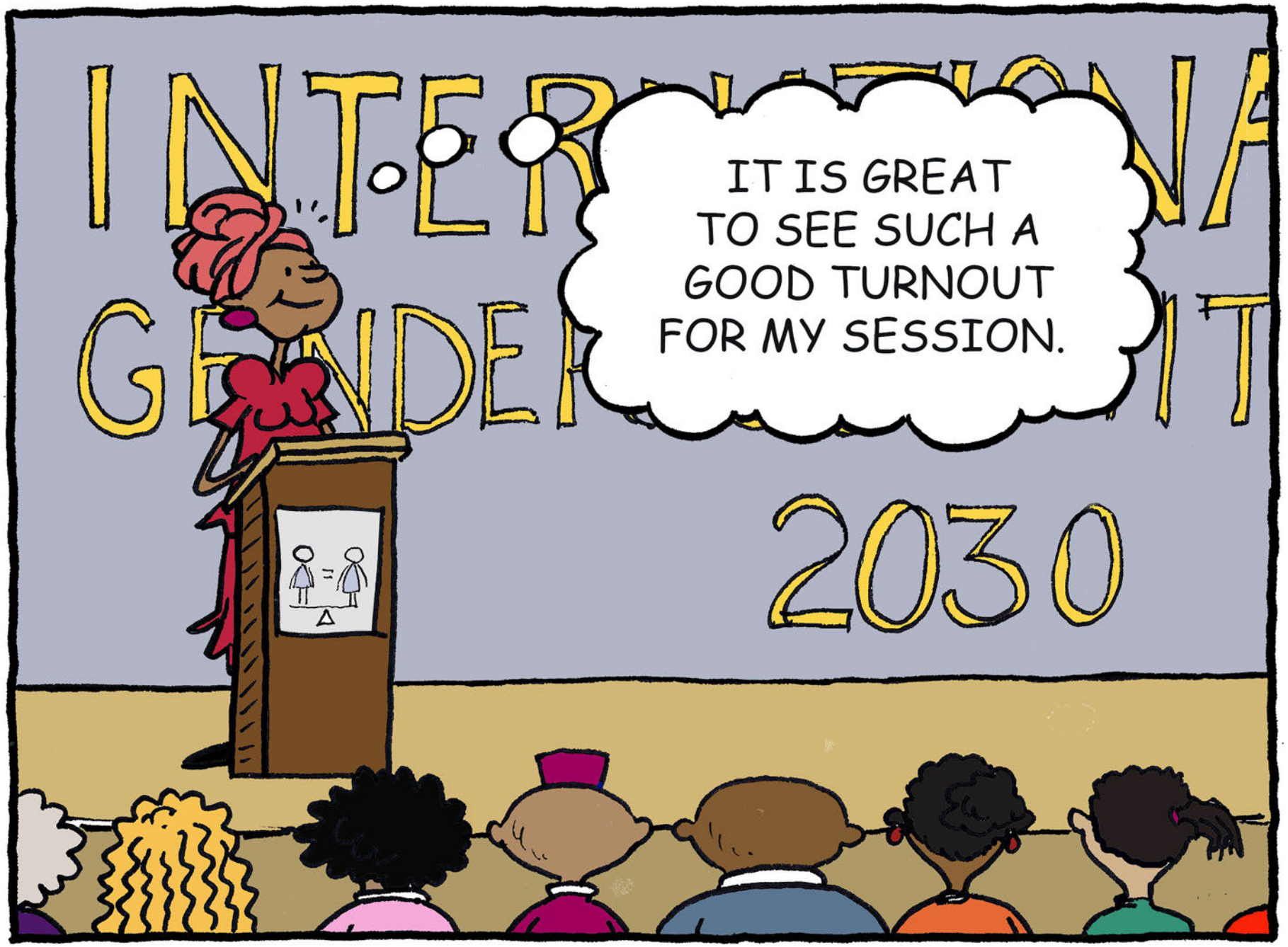
Governments that help to develop women's economic power and skills can unlock substantial benefits for their countries, as have regions that have embarked on these shifts. In particular, the off-grid energy industry can accelerate new learning and upskilling opportunities with, for example, LiFi connectivity, as well as through the development of more community-focused cooperative business models.

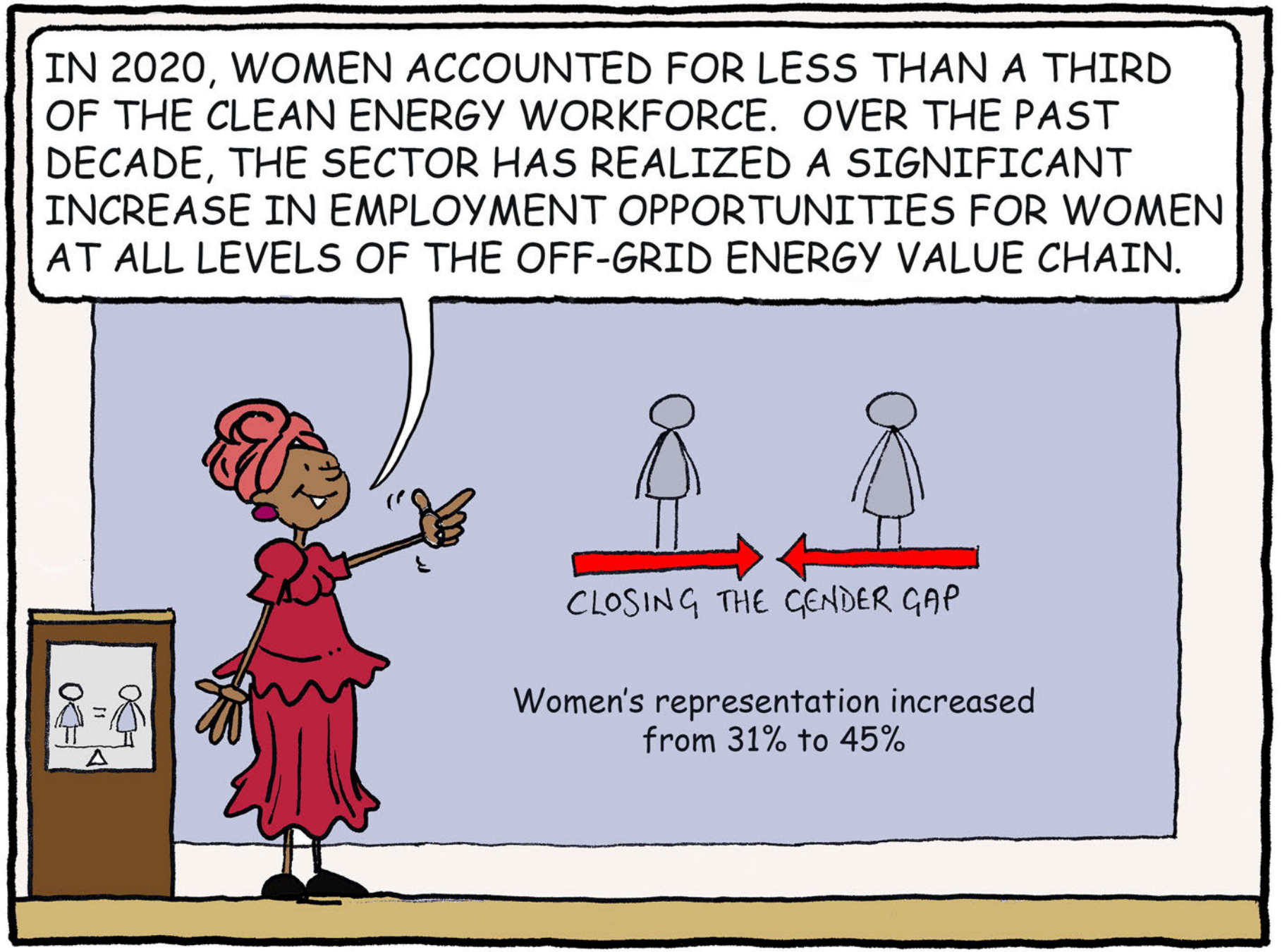
These efforts will require the support and involvement of men to promote gender equality and mitigate the potential backlash of gender-based violence which often accompanies large social change.

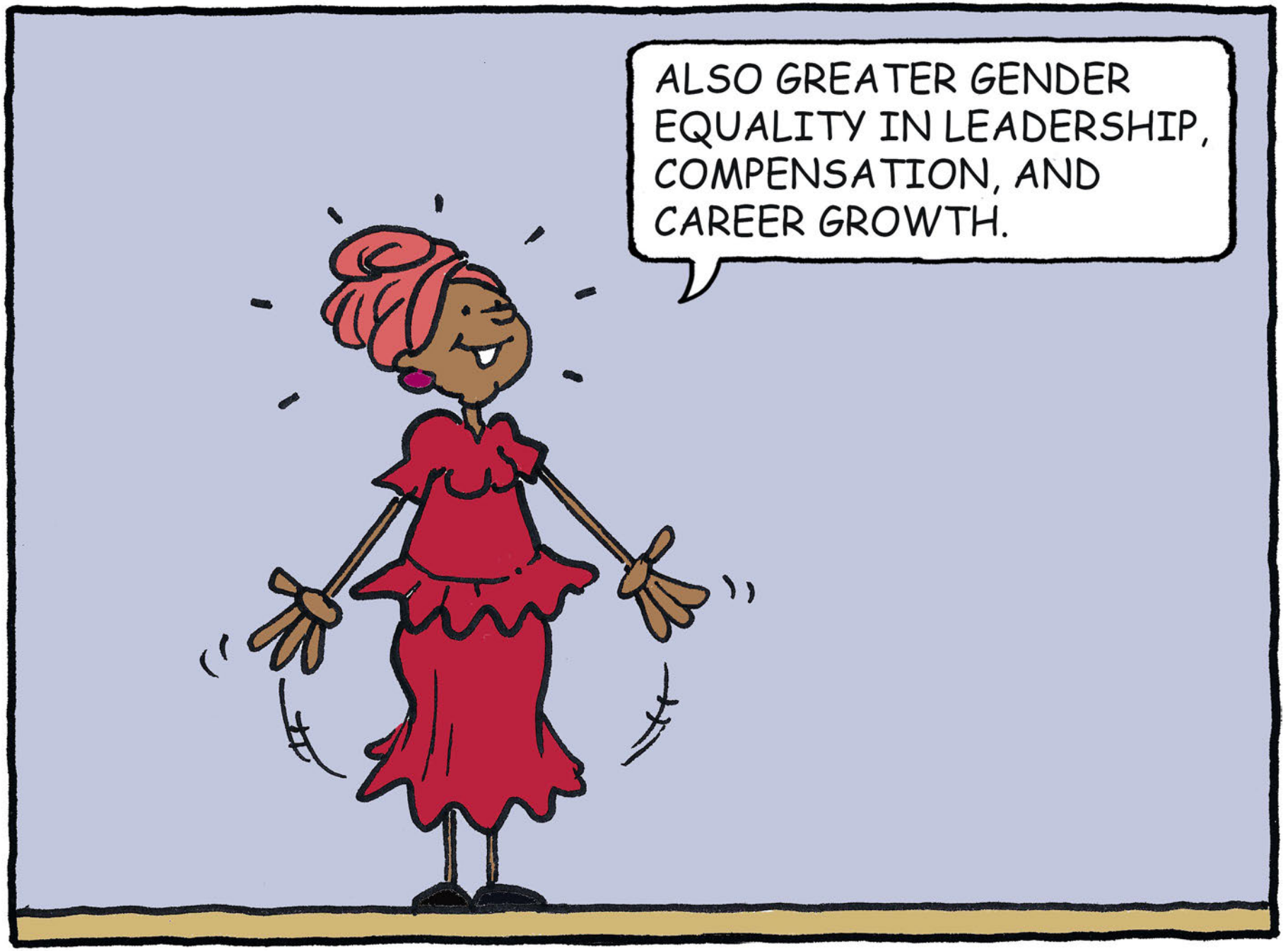
SCENARIO: GENDER EQUALITY IN 2030

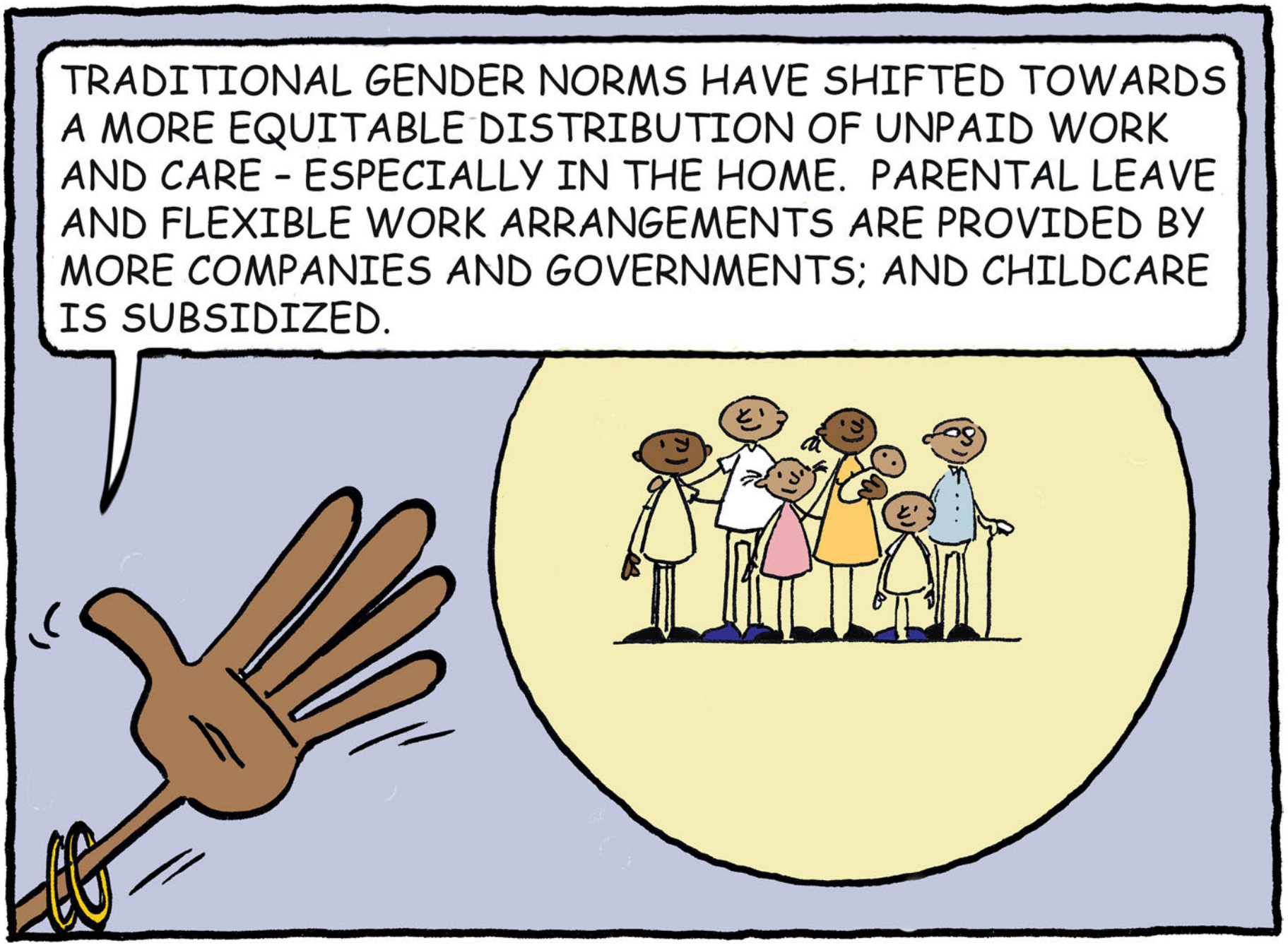
The following scenario for 2030 imagines a possible future world. It is not meant to operate as a prediction of events, but rather to provoke thought around future possibilities. The scenario aims to empower the reader to imagine the possible outcomes, over a ten-year time frame, of actions and policies we adopt today.

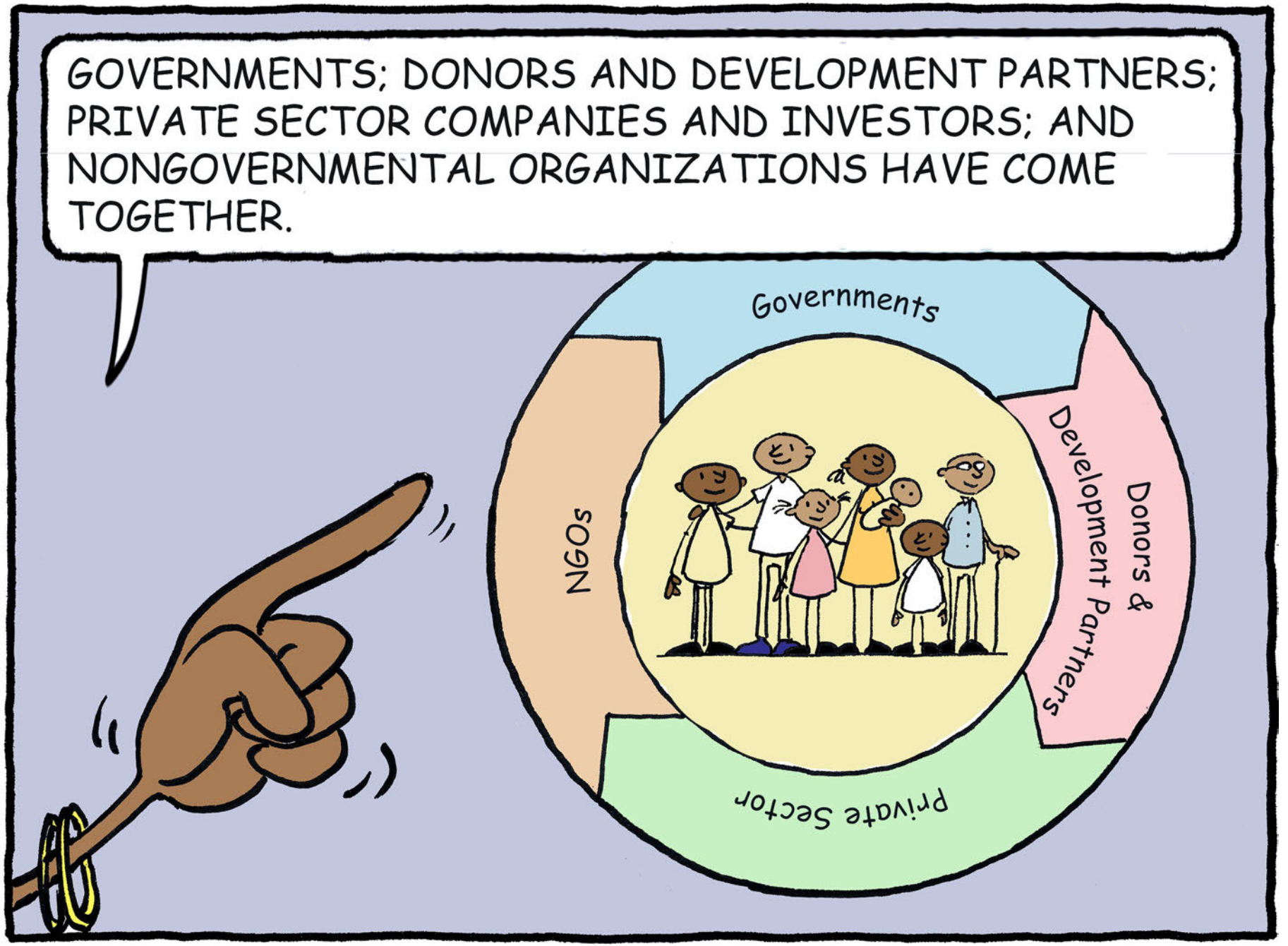

CAPE TOWN, SOUTH AFRICA. THE YEAR IS 2030. THE WORLD IS MAKING PROGRESS TOWARDS ACHIEVING GENDER EQUALITY IN EDUCATION, ECONOMIC DEVELOPMENT, HEALTH, AND POLITICAL EMPOWERMENT. MORE WOMEN THAN EVER ARE BEING EMPLOYED INTO EMERGING HIGH-GROWTH ROLES. POLICY FRAMEWORKS IN MANY REGIONS SUPPORT THE ADVANCEMENT OF WOMEN'S ACCESS TO RESOURCES AND OPPORTUNITIES.
INTERNATIONAL GENDER EQUALITY SUMMIT 2030
CTICC
CAPE TOWN INTERNATIONAL CONVENTION CENTRE

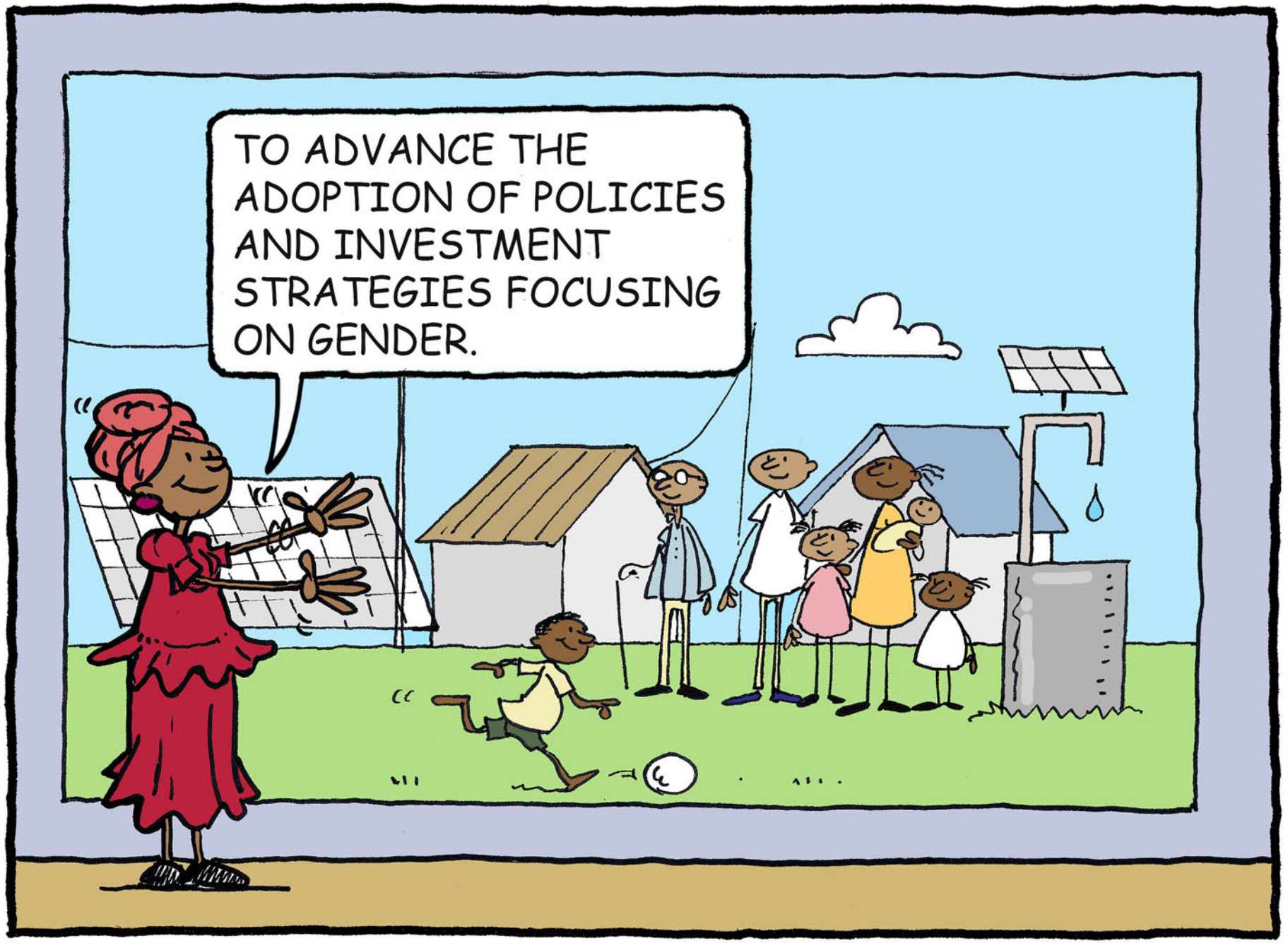

IT IS GREAT TO SEE SUCH A GOOD TURNOUT FOR MY SESSION.
2030


IN 2020, WOMEN ACCOUNTED FOR LESS THAN A THIRD OF THE CLEAN ENERGY WORKFORCE. OVER THE PAST DECADE, THE SECTOR HAS REALIZED A SIGNIFICANT INCREASE IN EMPLOYMENT OPPORTUNITIES FOR WOMEN AT ALL LEVELS OF THE OFF-GRID ENERGY VALUE CHAIN.
CLOSING THE GENDER GAP
Women's representation increased from 31% to 45%

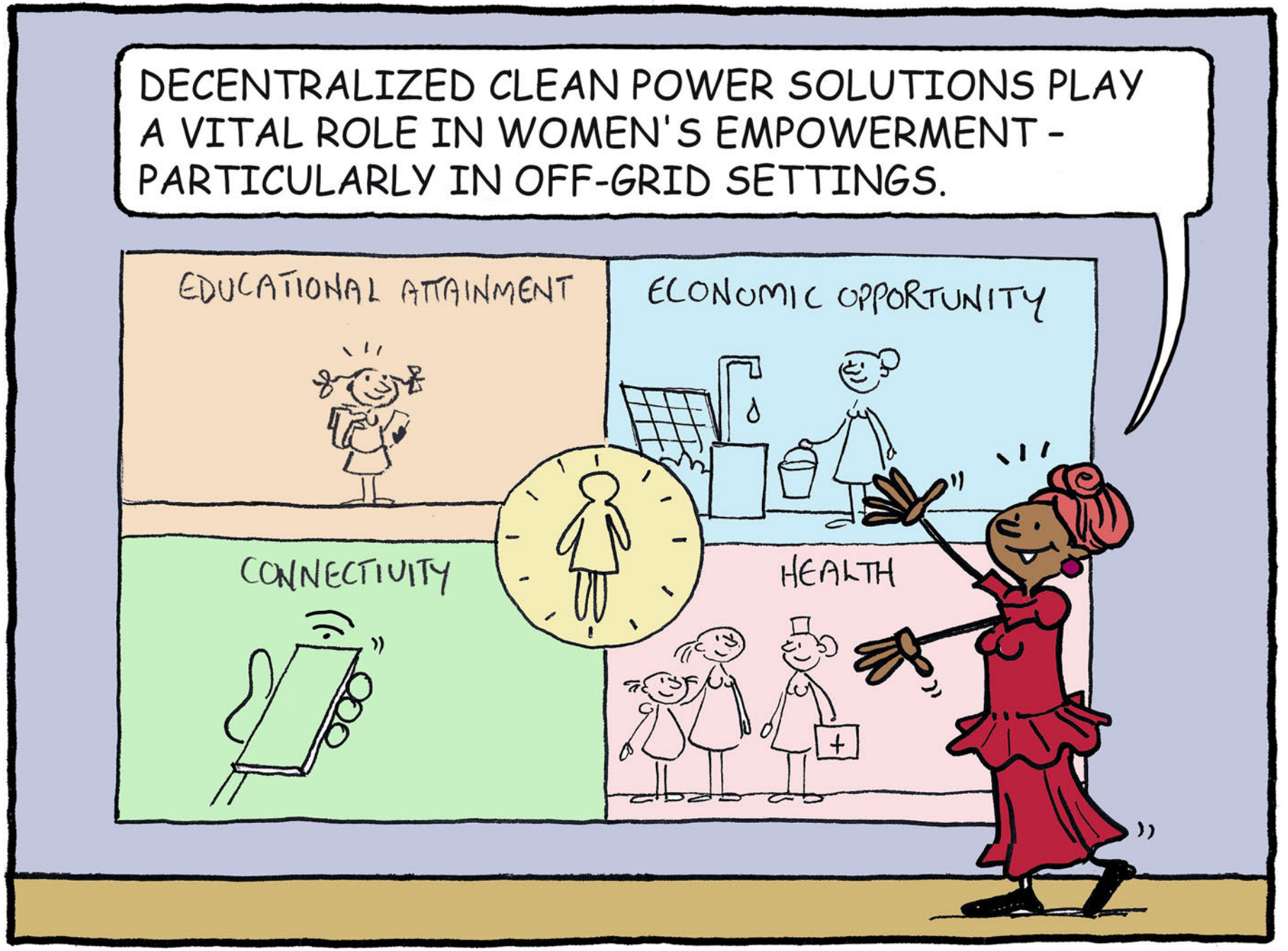

ALSO GREATER GENDER EQUALITY IN LEADERSHIP, COMPENSATION, AND CAREER GROWTH.


TRADITIONAL GENDER NORMS HAVE SHIFTED TOWARDS A MORE EQUITABLE DISTRIBUTION OF UNPAID WORK AND CARE - ESPECIALLY IN THE HOME. PARENTAL LEAVE AND FLEXIBLE WORK ARRANGEMENTS ARE PROVIDED BY MORE COMPANIES AND GOVERNMENTS; AND CHILDCARE IS SUBSIDIZED.

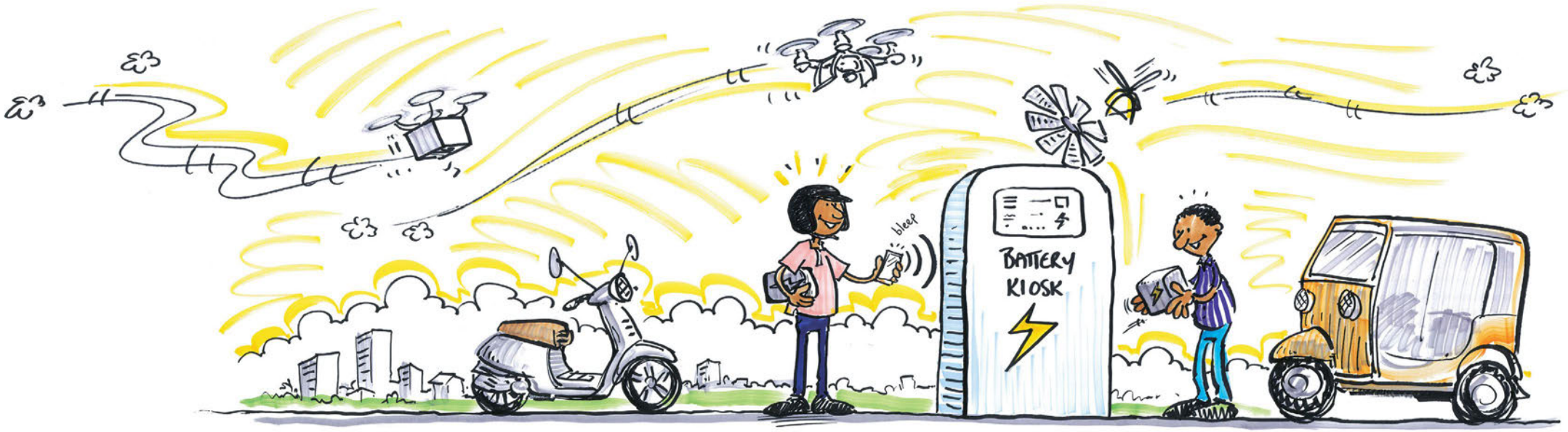

GOVERNMENTS; DONORS AND DEVELOPMENT PARTNERS; PRIVATE SECTOR COMPANIES AND INVESTORS; AND NONGOVERNMENTAL ORGANIZATIONS HAVE COME TOGETHER.
Governments
Donors & Development Partners
Private Sector
NGOs


TO ADVANCE THE ADOPTION OF POLICIES AND INVESTMENT STRATEGIES FOCUSING ON GENDER.


SUSTAINABLE ENERGY IS AN ENABLER FOR DEVELOPMENT.
1 NO POVERTY
5 GENDER EQUALITY
11 SUSTAINABLE CITIES AND COMMUNITIES
3 GOOD HEALTH AND WELL-BEING
7 AFFORDABLE AND CLEAN ENERGY
13 CLIMATE ACTION


DECENTRALIZED CLEAN POWER SOLUTIONS PLAY A VITAL ROLE IN WOMEN'S EMPOWERMENT - PARTICULARLY IN OFF-GRID SETTINGS.
EDUCATIONAL ATTAINMENT
ECONOMIC OPPORTUNITY
CONNECTIVITY
HEALTH


DESPITE THE PROGRESS MADE, THERE IS STILL MUCH WORK TO BE DONE... LET'S STAY FOCUSED - WE CAN ACHIEVE OUR GOALS TOGETHER. JËREJËF!*
2030
*THANK YOU (IN WOLOF)



OFF-GRID AND E-MOBILITY

Battery technology innovations and manufacturing economies-of-scale continue to drive down cost and size while also increasing the performance of commercially available batteries. As innovations continue to arise, the set of commercially viable formats and applications of portable electric power will continue to expand.

One area of new possibilities is the transportation of people and goods. Declining battery prices, e-mobility start-up companies, and drone delivery services are just some of the key drivers and signals of an off-grid future with e-mobility.

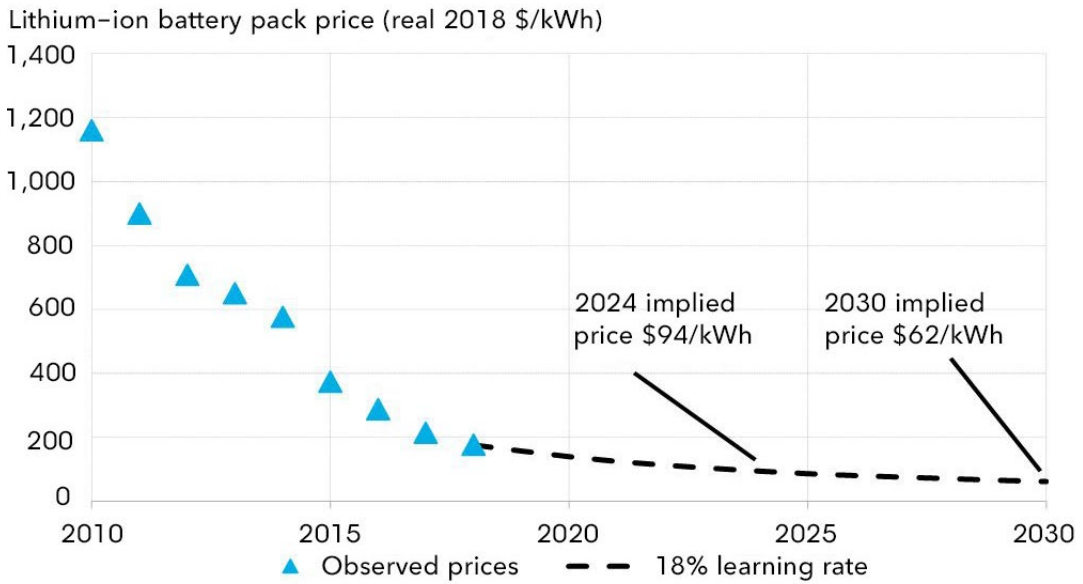
These innovations in battery technology are likely to create new sectors of the economy and lead to a revitalizing of existing sectors. Infrastructure in sub-Saharan Africa may leap-frog the growth-path of developed countries and become more decentralized, leveraging current and upcoming technologies.

Developments in industries adjacent to the off-grid mobility sector will drive the evolution of decentralized power over the next decade. These drivers include decreasing battery costs, technology-enabled advancements in informal economy business models, and the growing threat of e-waste as battery-based services gain greater market share globally.

Driver 1: Decreasing battery costs

- The cost of battery capacity will continue to drop for the next decade (Figure) to compete with the price of internal combustion engines (ICE).[38]
- Economies of scale are placing additional downward pressure on battery prices as global manufacturing capacity continues to increase.[39] Currently, battery manufacturers around the world plan to create an additional 100 GWh of lithium-ion manufacturing capacity, with more expected by 2024.[40]
- Average lithium-ion battery prices are expected to fall by 46 percent by 2029.[41]

Lithium-ion Battery Price Outlook



Source: BloombergNEF

Photo Credit: Power Africa

[38] "Battery Pack Prices Fall as Market Ramps up with Market Average at $ 156/kWh in 2019," BloombergNEF, December 3, 2019, accessed June 25, 2021, https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/.

[39] Nicholas Nhede, "Cell Prices for Lithium-ion Batteries to Decline by 46%," Smart Energy International, June 6, 2020, accessed June 25, 2021, www.smart-energy.com/industry-sectors/storage/cell-prices-for-lithium-ion-batteries-to-decline-by-46/.

[40] Andy Colthorpe, "Guidehouse: Lithium Battery Prices to Almost Halve by 2029," *Energy Storage News*, June 9, 2020, accessed June 25, 2021, www.energy-storage.news/news/guidehouse-lithium-battery-cell-prices-to-almost-halve-by-2029.

[41] Kip Keen, "As Battery Costs Plummet, Lithium-ion Innovation Hits Limits, Experts Say," S&P Global Market Intelligence, May 14, 2020, accessed June 25, 2020, www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/as-battery-costs-plummet-lithium-ion-innovation-hits-limits-experts-say-58613238.

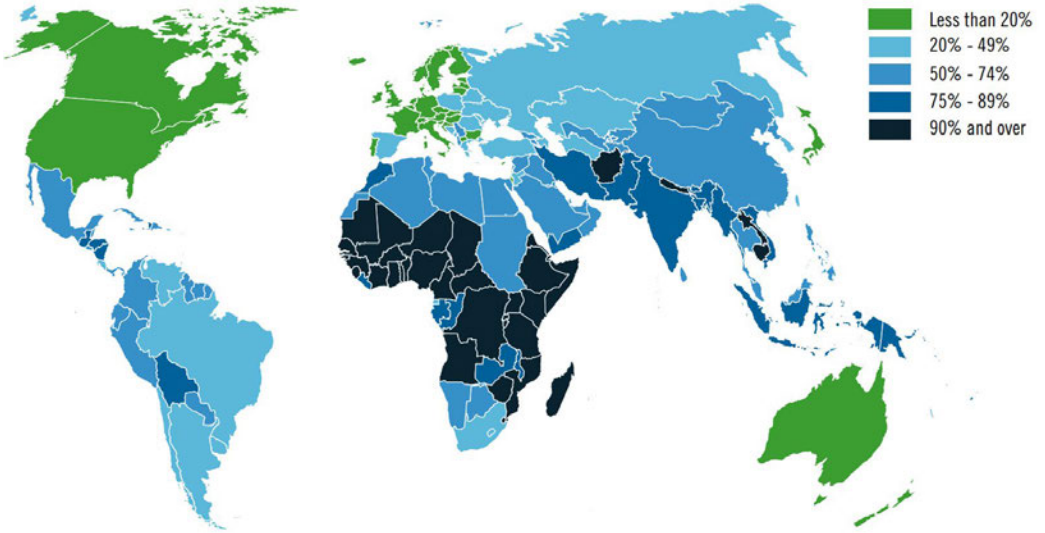
Driver 2: Economic growth, inequality, and the informal economy

One of the key drivers of economic growth is increased labor productivity via capital accumulation. However, growth has not been inclusive and high levels of income inequality remain.

Large and rising fiscal deficits hinder growth and delay much-needed infrastructure investments. A major cause of these fiscal deficits is lower tax revenues as a percentage of GDP compared to those countries with similar national incomes, but with more established systems of tax collection in other parts of the world. This shortfall in revenue is due in large part to the high number of people employed in the informal economy and difficulties in pushing towards formalization.[42]

- Across the African continent, 85.8 percent of employment is in the informal economy. For most countries in sub-Saharan Africa, the percentage of people employed in the informal economy is over 90 percent (Figure).[43]
- The informal economy is also the main source of employment for women and the youth (ages 15–24) in sub-Saharan African countries, at 95.8 percent and 92.1 percent respectively.[43]

Share of Employment in Informal Economy



Source: International Labour Office

Driver 3: The looming issue of e-waste

With continued growth of the off-grid solar market globally, waste streams will face a surge of retired equipment in the coming years. This is equally true for the sub-Saharan African market.

- If the use of batteries increases globally due to the adoption of electric vehicles and solar power, soon after there will be a glut of used batteries and PV panels.[44] Currently, our global recycling supply chain is not set up to absorb this increase.
- Further research is required properly to evaluate the risks and opportunities of accumulating e-waste. The urgency of this issue is likely to grow considerably in the coming decade.

[42] African Development Bank, *African Economic Outlook 2020: Amid COVID-19* (Abidjan, Côte d'Ivoire: African Development Bank, 2020), https://afdb.org/en/documents/african-economic-outlook-2020-supplement.
[43] International Labor Office, *Women and Men in the Informal Economy: A Statistical Picture* (Geneva, Switzerland: International Labor Office, 2018), www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_626831.pdf.
[44] Hameem Bin Hameed, Yousaf Ali, and Antonella Pertillo, "Environmental Risk Assessment of E-waste in Deceloping Countries by Using the Modified-SIRA Method," Science of the Total Environment 733 (2020), https://doi.org/10.1016/j.scitotenv.2020.138525.

The following signals indicate emerging technologies and practices that can scale and potentially disrupt the off-grid sector. These signals can help us make informed speculations as to how an African-centric off-grid mobility industry may emerge by 2030.

Signal 1: Swappable batteries for energy management

Ampersand in Rwanda employs a fleet of electric motorbike taxis that are powered by swappable batteries. Ampersand customers rent motorbikes and swappable batteries, earning income by offering taxi services. Ampersand customers will then swap their depleted batteries for full batteries at one of the numerous Ampersand battery stations. According to Ampersand, their customers on average take home $ 4.40 per day compared to the $ 1.60 of their petrol counterparts.[45]

Signal 2: Drone delivery with Zipline

Last-mile communities throughout sub-Saharan Africa are often left behind when it comes to access to goods and services that peri-urban and urban communities enjoy. However, one company employs a business model to ensure no community is left behind. With operations in Ghana, California-based Zipline can deliver a 3.85 pound (1.75 kilogram) payload anywhere within a 50 mile (80 kilometer) radius using its drone-delivery system.[46]

Signal 3: Association for Electric Mobility and Development in Africa (AEMDA)

In the absence of unifying regulations and industry standards, the e-mobility sector risks creating a patchwork of proprietary infrastructure. In contrast to the standards and infrastructure for refueling ICE vehicles, e-mobility comes with the risk of parallel infrastructure and no interoperability (e.g. in terms of charging connectors). In general, the nascent e-mobility market needs coordinated advocacy to secure an enabling environment.

Fortunately, the newly formed AEMDA aims to be that advocate. Focused on e-mobility education, policy advocacy, and the creation of technology standards, AEMDA is the leading industry organization for e-mobility in Africa.[47] As the sector continues to grow, it will be associations like AEMDA that will prepare the way for e-mobility to become mainstream.

[45] "Impact," Ampersand, accessed June 25, 2021, https://www.ampersand.solar/impact.
[46] "Zipline – How It Works," Zipline, accessed June 25, 2021, https://flyzipline.com/how-it-works/.
[47] "About Us," Association for Electric Mobility and Development in Africa, 2020, accessed June 25, 2021, https://aemda.org/about/.

POSSIBILITIES FOR OFF-GRID E-MOBILITY BY 2030

The evolution of off-grid energy in the next decade will be influenced by adjacent sectors, including the transportation sector. For sub-Saharan Africa, a defining characteristic of transit systems is privately-owned public transit. Although there are variations from country to country, "tro-tros," "danfos," and "matatus" are a key part of how people and goods move around. Right now, many of these vehicles operate with ICE. As electric vehicle (EV) costs decline over the next decade, it is plausible that these transit systems will electrify.

Mobility does not mean only personal transport – it can also mean logistics. Logistics in sub-Saharan Africa cities is highly multi-modal. Although consumer-facing use cases are the most visible, industry applications are macro-economically important. How businesses get things and people from A to B will be a significant indicator of what energy is needed where, and how last-mile distribution is ultimately shaped.

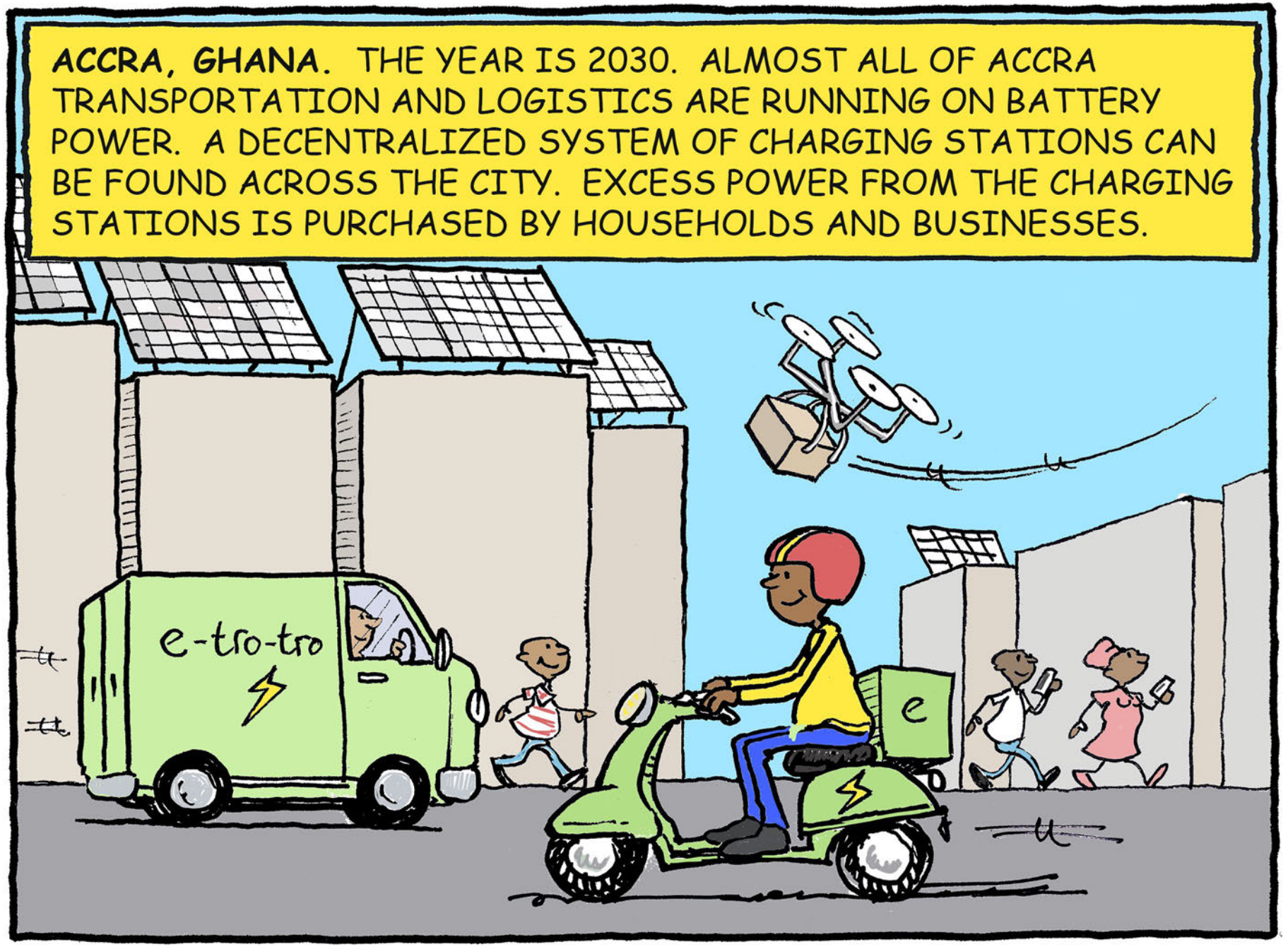
However, transition to EVs is unlikely to happen gradually because such new forms of transit would need to be accompanied by supporting infrastructure. Whoever makes these large initial capital investments to introduce EV-supporting infrastructure, thus owning it, will have downstream implications for a very long time. This investor might be the government, a private actor, or some form of public-private partnership. The first mover that provides the upfront capital investment required for EV infrastructure will be able to determine the growth of this market.

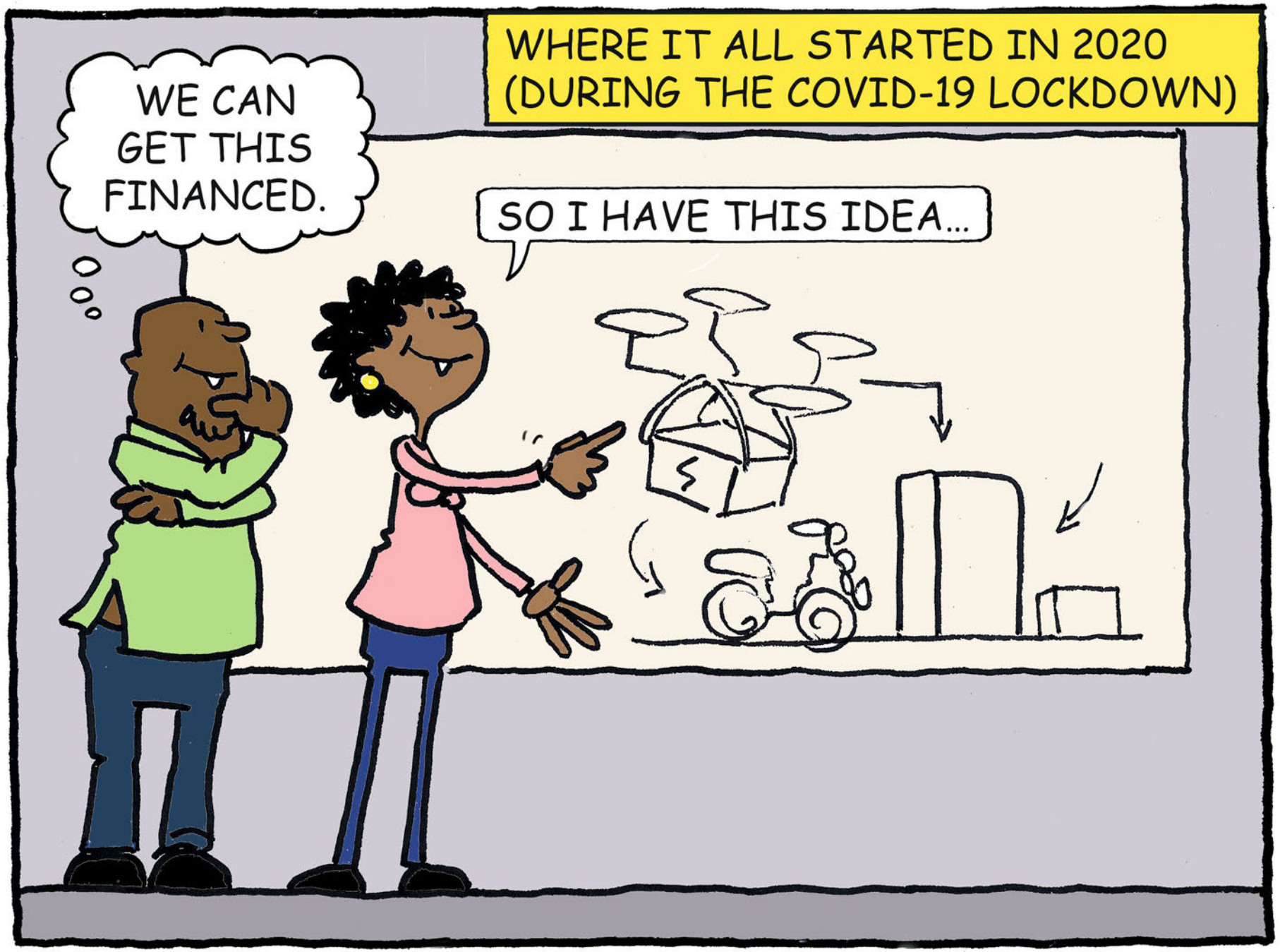
As more modes of transit electrify, it is likely that the underlying business model and structure for the transport system will remain the same, with the new technology layering over existing economic and regulatory structures. The emergent nature of privately-owned public transit systems has the benefit of flexibility and adaptability; these systems respond to local demand quickly with little centralized coordination. However, there are also downsides like unenforced vehicle quality standards, decreased legal protections for customers, and service limited to areas only where profits can be realized. Electrification will become a part of this existing system with its existing benefits and drawbacks unless e-mobility is accompanied by other reforms.

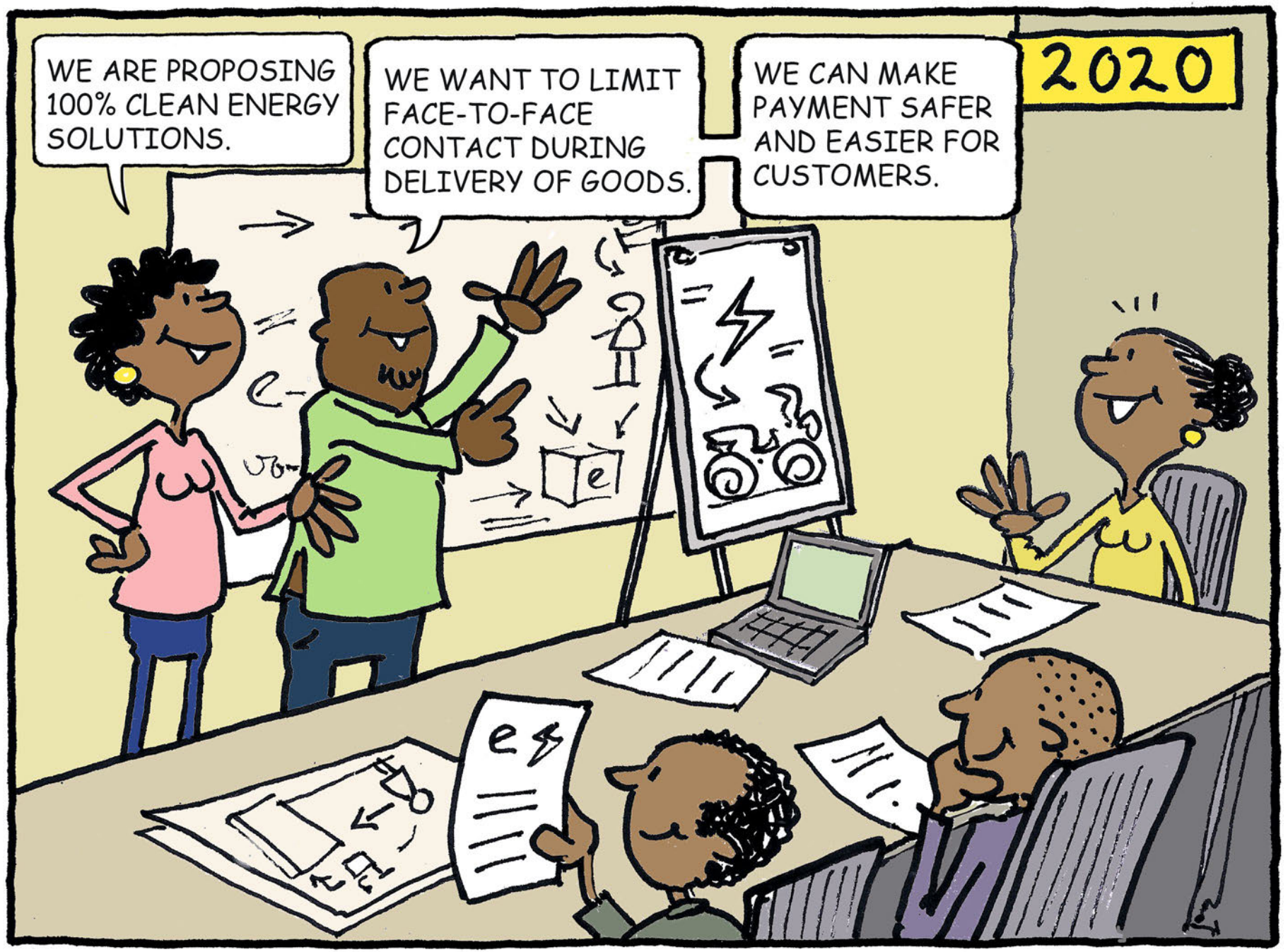
One such reform that might be more critical than others is to regulate e-waste. Poorly disposed batteries can have disastrous health consequences. PV panels require specific recycling facilities to recover usable materials. While some countries may deal with this by paying to send the e-waste elsewhere, this option is unaffordable for most sub-Saharan African countries. However, with the right investments and strategy planning, recycling e-waste produced by off-grid activities can be a lucrative opportunity, especially for those countries currently investing heavily in PV generation.

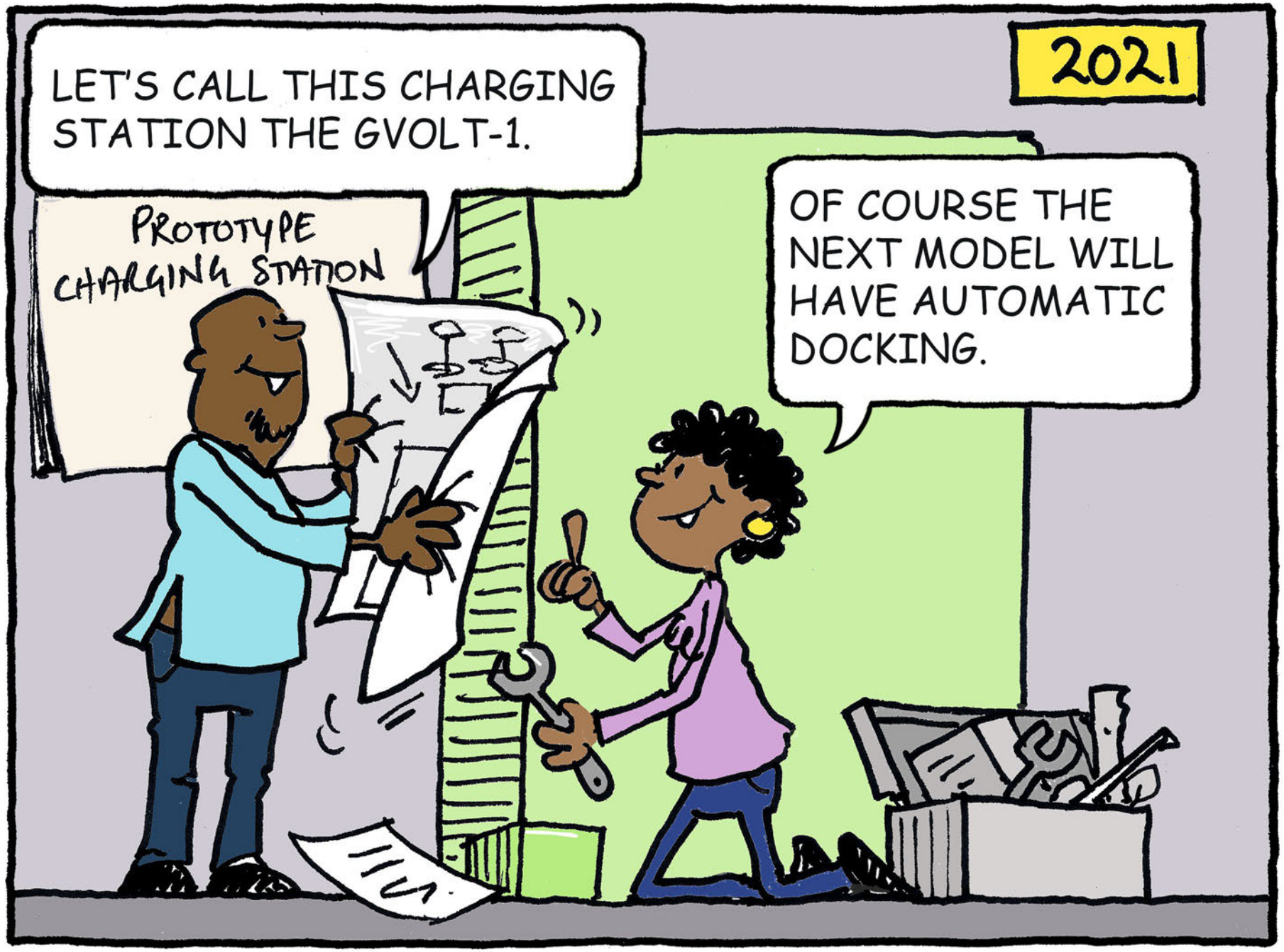
SCENARIO: OFF-GRID E-MOBILITY IN 2030

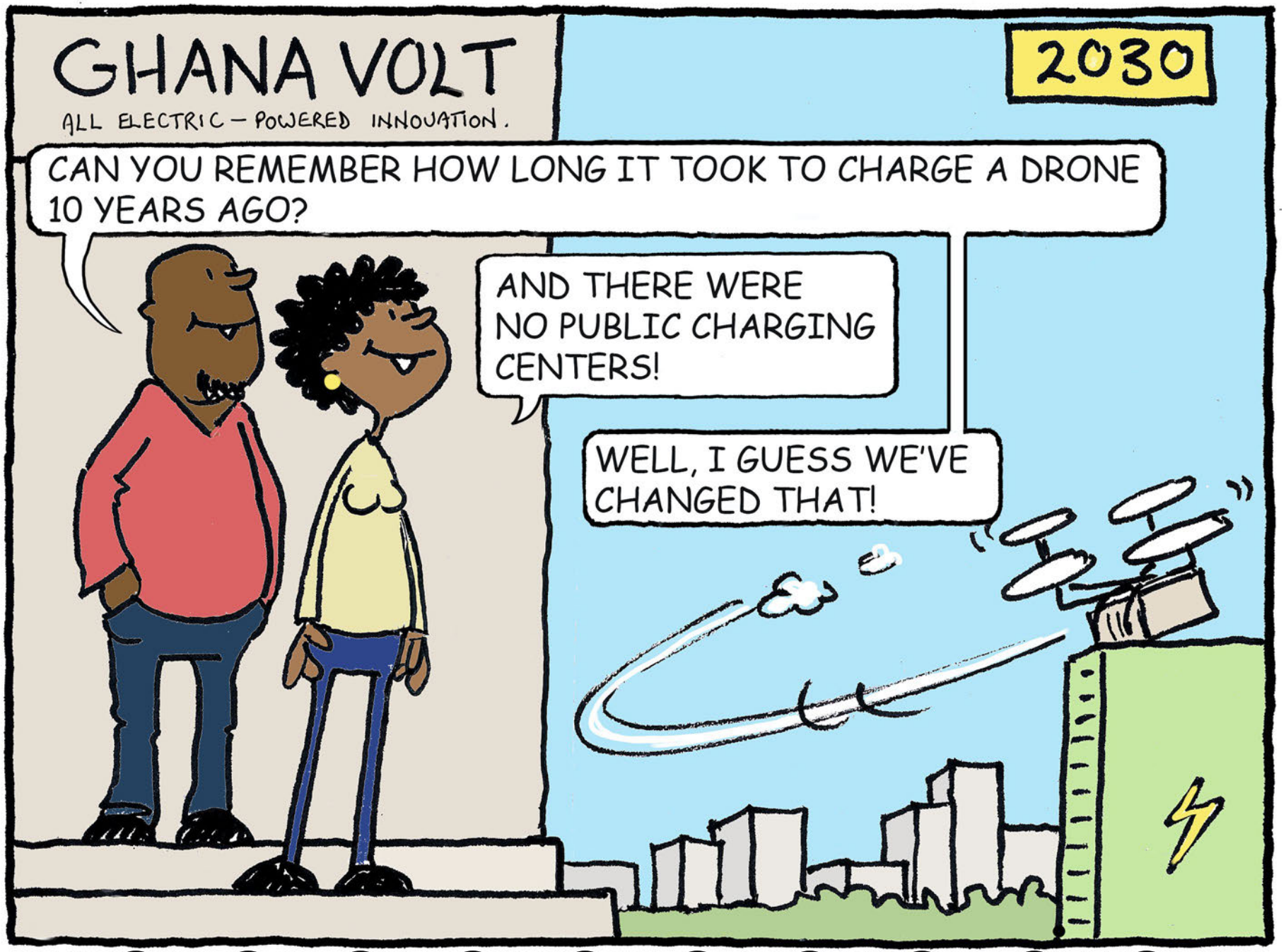
The following scenario for 2030 imagines a possible future world. It is not meant to operate as a prediction of events, but rather to provoke thought around future possibilities. The scenario aims to empower the reader to imagine the possible outcomes, over a ten-year time frame, of actions and policies we adopt today.

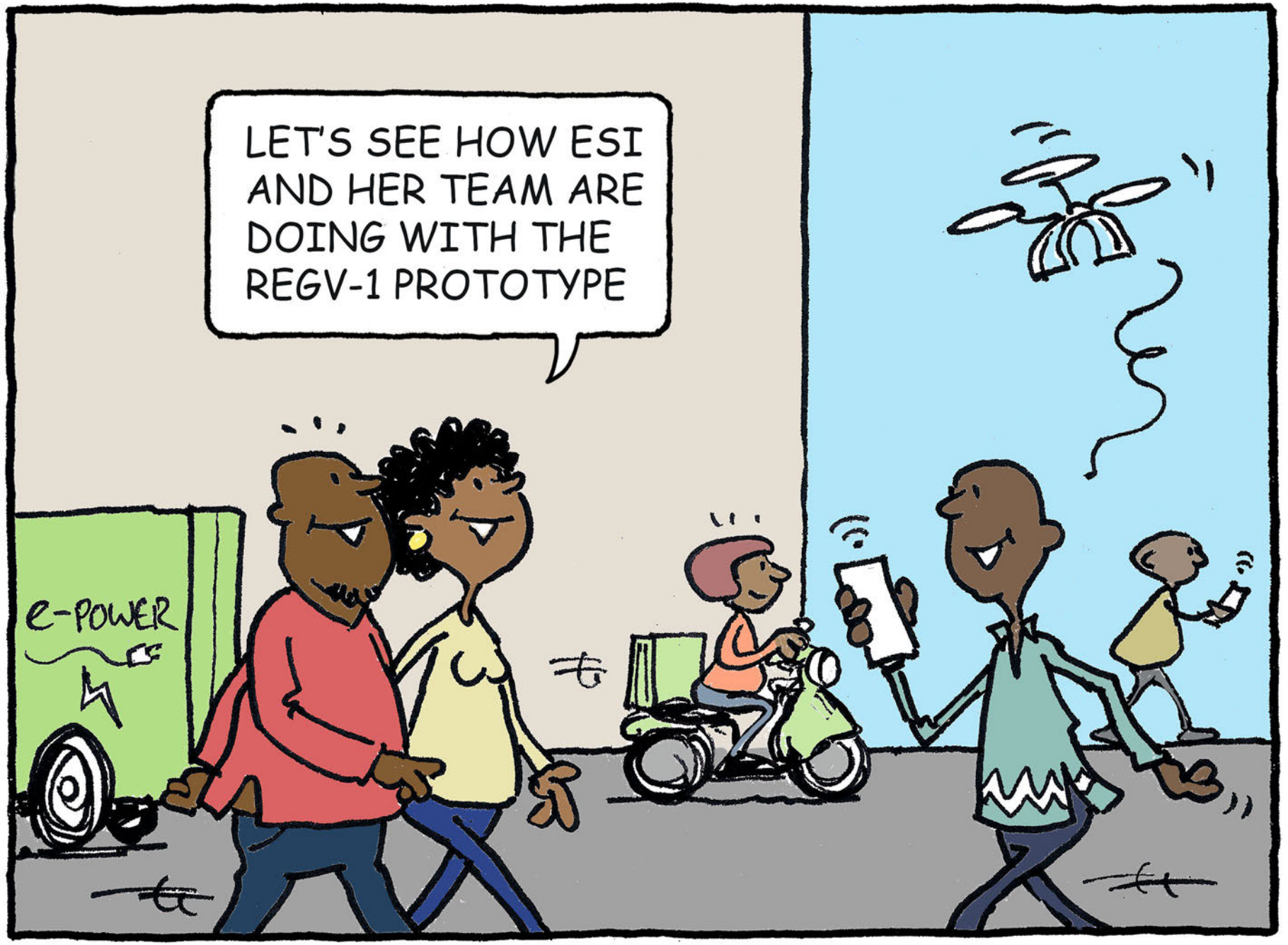

ACCRA, GHANA. THE YEAR IS 2030. ALMOST ALL OF ACCRA TRANSPORTATION AND LOGISTICS ARE RUNNING ON BATTERY POWER. A DECENTRALIZED SYSTEM OF CHARGING STATIONS CAN BE FOUND ACROSS THE CITY. EXCESS POWER FROM THE CHARGING STATIONS IS PURCHASED BY HOUSEHOLDS AND BUSINESSES.
e-tro-tro
e

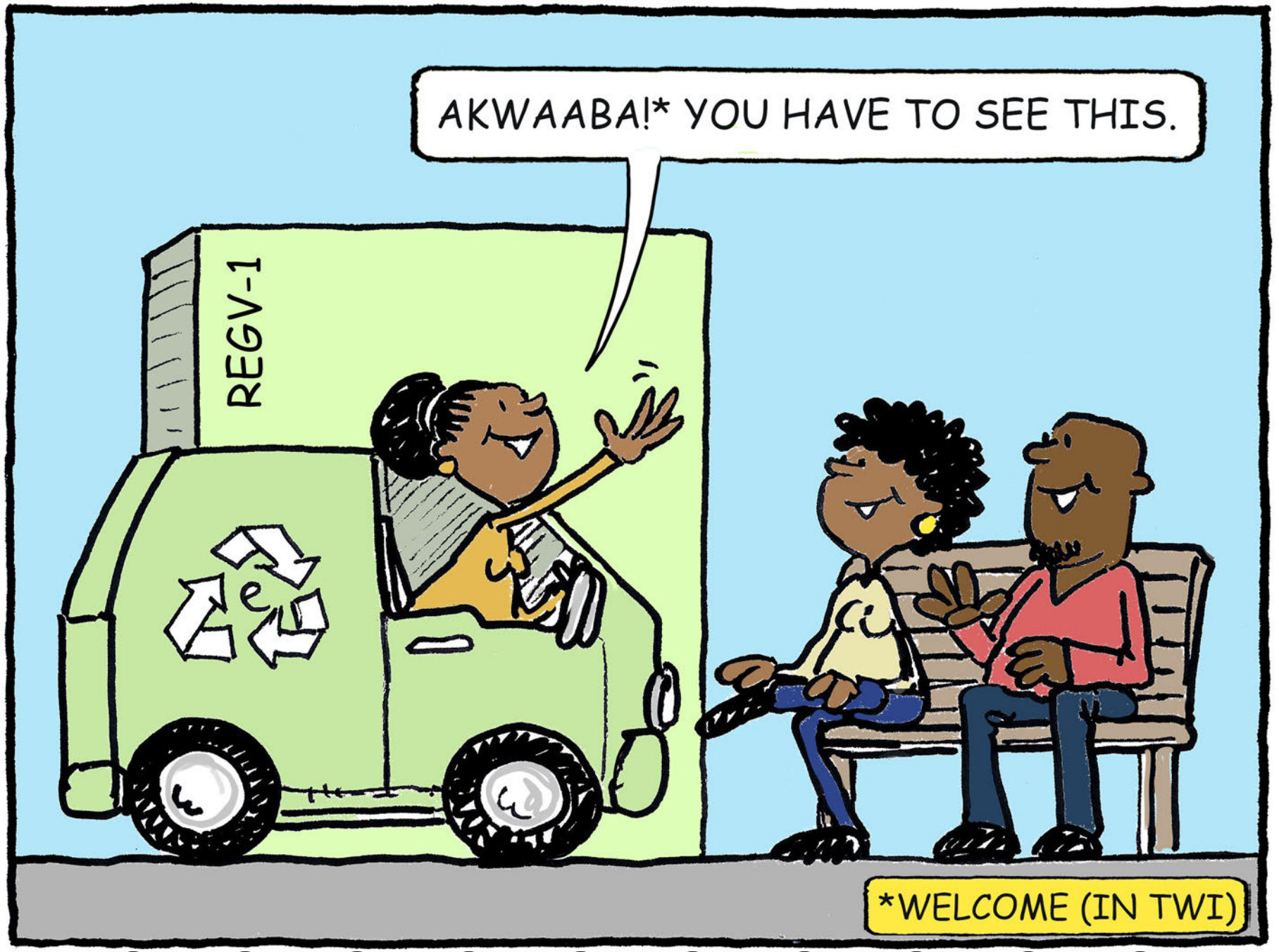

WHERE IT ALL STARTED IN 2020
(DURING THE COVID-19 LOCKDOWN)
WE CAN GET THIS FINANCED.
SO I HAVE THIS IDEA...

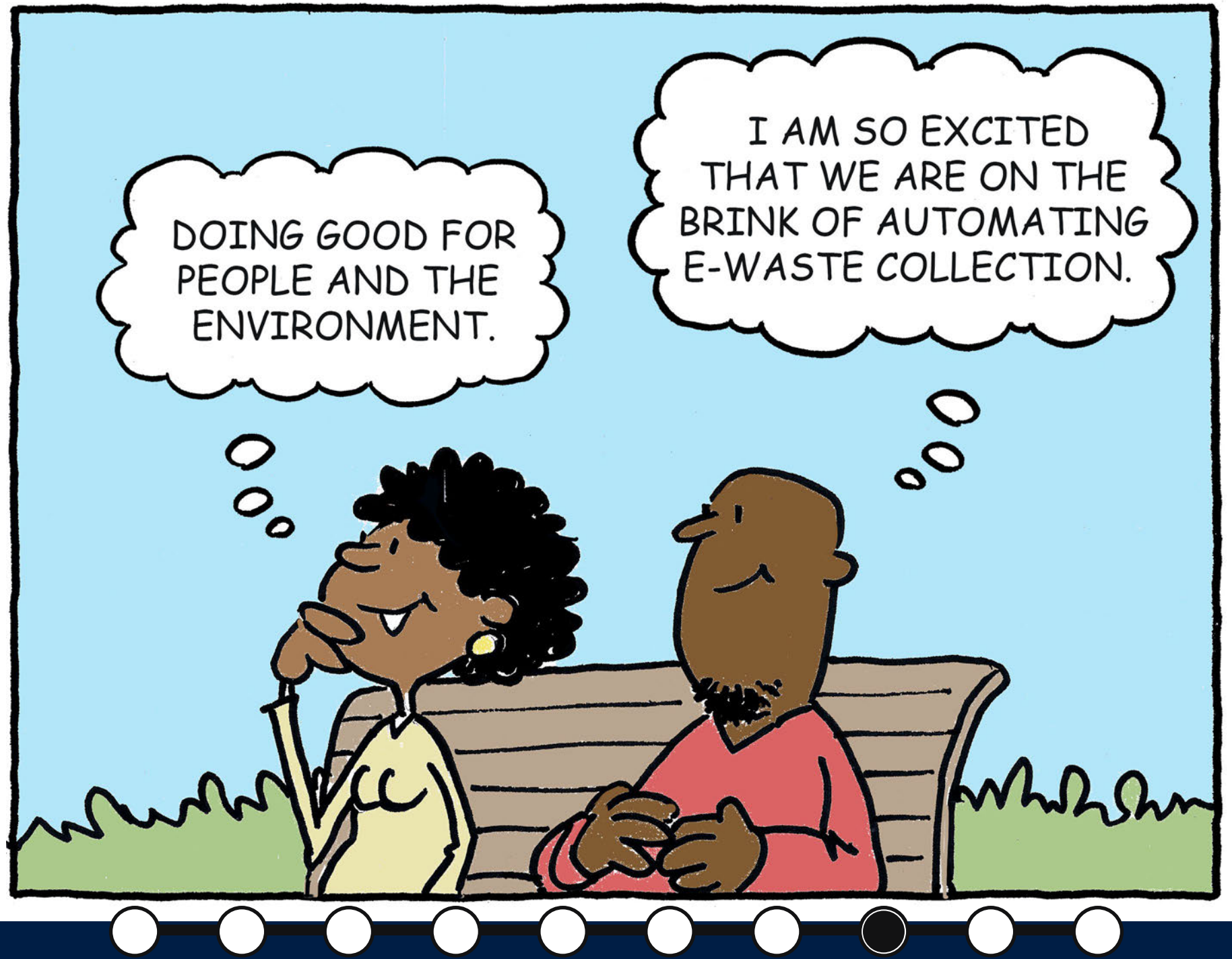

WE ARE PROPOSING 100% CLEAN ENERGY SOLUTIONS.
WE WANT TO LIMIT FACE-TO-FACE CONTACT DURING DELIVERY OF GOODS.
WE CAN MAKE PAYMENT SAFER AND EASIER FOR CUSTOMERS.
2020

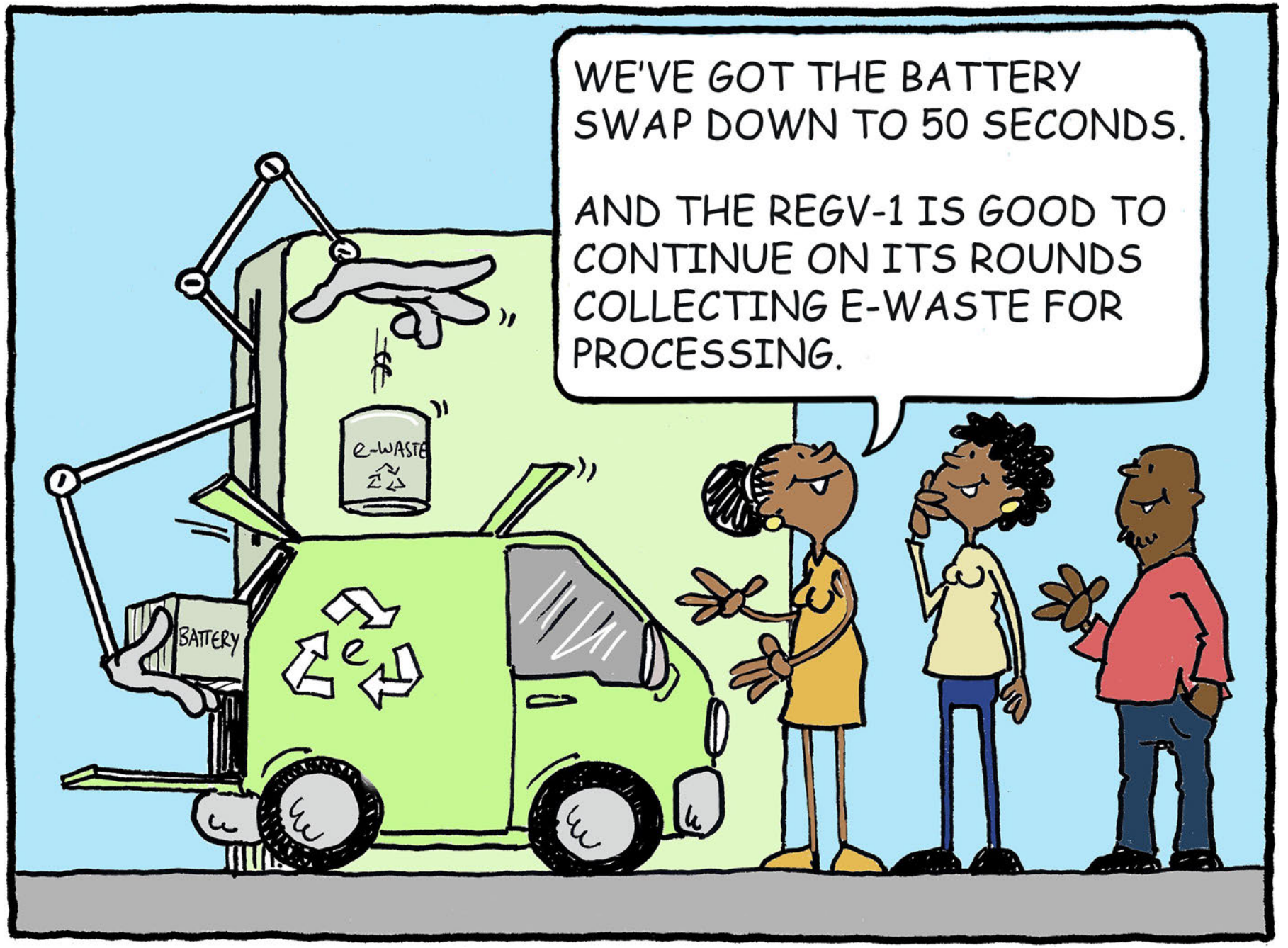

LET'S CALL THIS CHARGING STATION THE GVOLT-1.
2021
PROTOTYPE CHARGING STATION
OF COURSE THE NEXT MODEL WILL HAVE AUTOMATIC DOCKING.

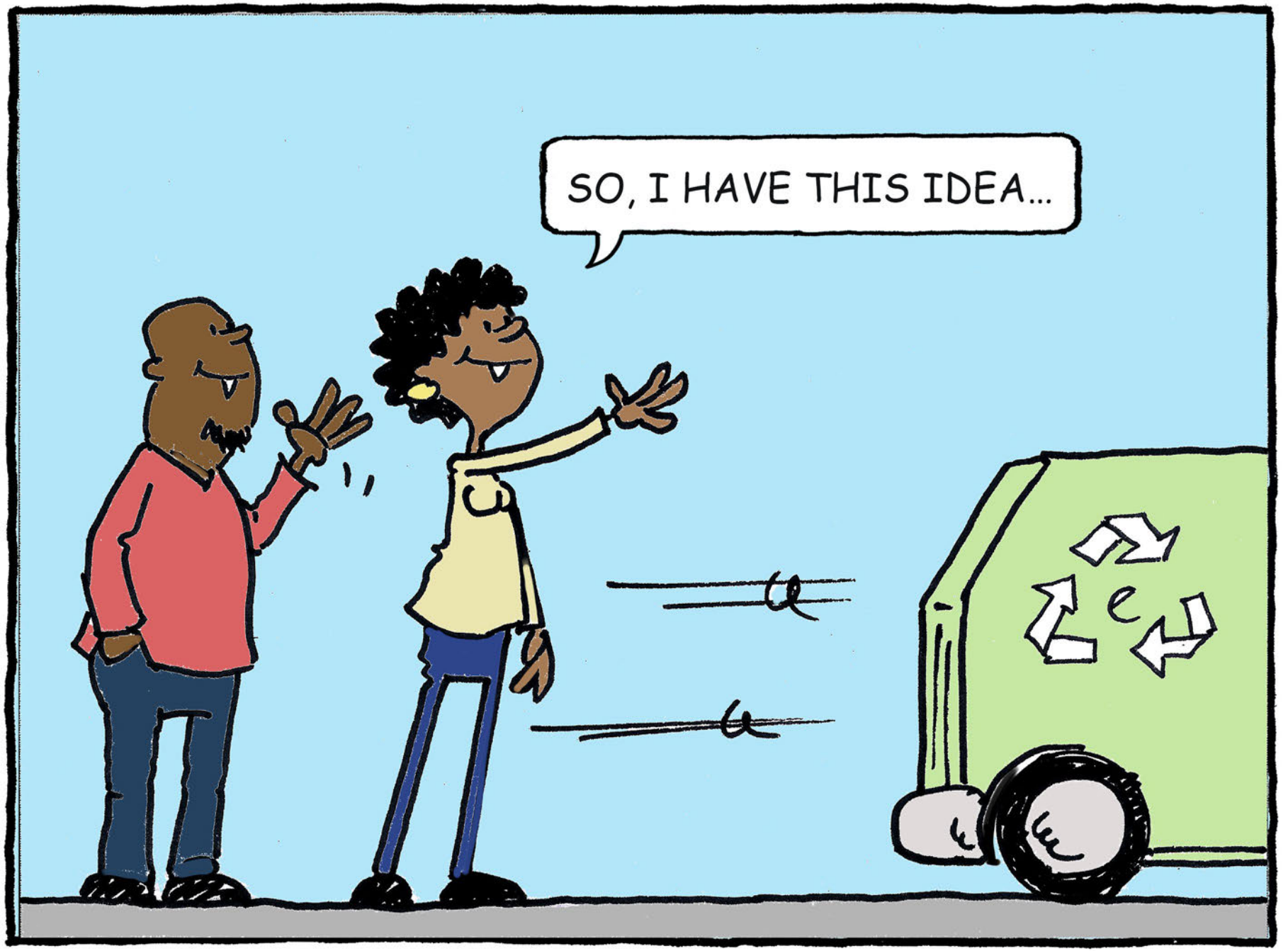

GHANA VOLT
ALL ELECTRIC – POWERED INNOVATION.
2030
CAN YOU REMEMBER HOW LONG IT TOOK TO CHARGE A DRONE 10 YEARS AGO?
AND THERE WERE NO PUBLIC CHARGING CENTERS!
WELL, I GUESS WE'VE CHANGED THAT!


LET'S SEE HOW ESI AND HER TEAM ARE DOING WITH THE REGV-1 PROTOTYPE
e-POWER


AKWAABA!* YOU HAVE TO SEE THIS.
REGV-1
*WELCOME (IN TWI)


DOING GOOD FOR PEOPLE AND THE ENVIRONMENT.
I AM SO EXCITED THAT WE ARE ON THE BRINK OF AUTOMATING E-WASTE COLLECTION.


WE'VE GOT THE BATTERY SWAP DOWN TO 50 SECONDS.
AND THE REGV-1 IS GOOD TO CONTINUE ON ITS ROUNDS COLLECTING E-WASTE FOR PROCESSING.
e-WASTE
BATTERY


SO, I HAVE THIS IDEA...

This report aims to present an accessible introduction to strategic foresighting as a tool for envisioning and considering potential futures. To help readers immerse themselves in the foresight methodology applied, the scenarios on the preceding pages include illustrations of fictional characters in an imagined world. The contents of this report describe but one example of a range of foresight methods that can inform future-oriented decision-making.

CONCLUSION

Renewable energy – including off-grid solar solutions – provides environmentally friendly and sustainable power options for sub-Saharan Africa. This report describes drivers and signals for macrotrends of change that impact the off-grid energy sector and the nexus of related sectors. It reflects on trends, disruptions, innovations, and behaviors to reveal possible future scenarios for the off-grid industry and communities relying on renewable power sources.

This report does not intend to predict specific outcomes but rather aims to share insight into current trends that affect off-grid energy development, application, demand, and access. The forecasts and scenarios included show risks and opportunities to inform decision makers as they develop strategies for adopting or expanding off-grid energy technologies to advance sustainable development.

While the future may be as uncertain as ever, proactive strategy that anticipates challenges, identifies opportunities, and envisages preferred outcomes, help us to plan for the future. If we hope to see preferred outcomes become realities by 2030, strategic action and planning should take place now.

Power Africa's goal is to add at least 30,000 megawatts (MW) of cleaner and more reliable electricity generation capacity and 60 million new home and business connections by 2030.